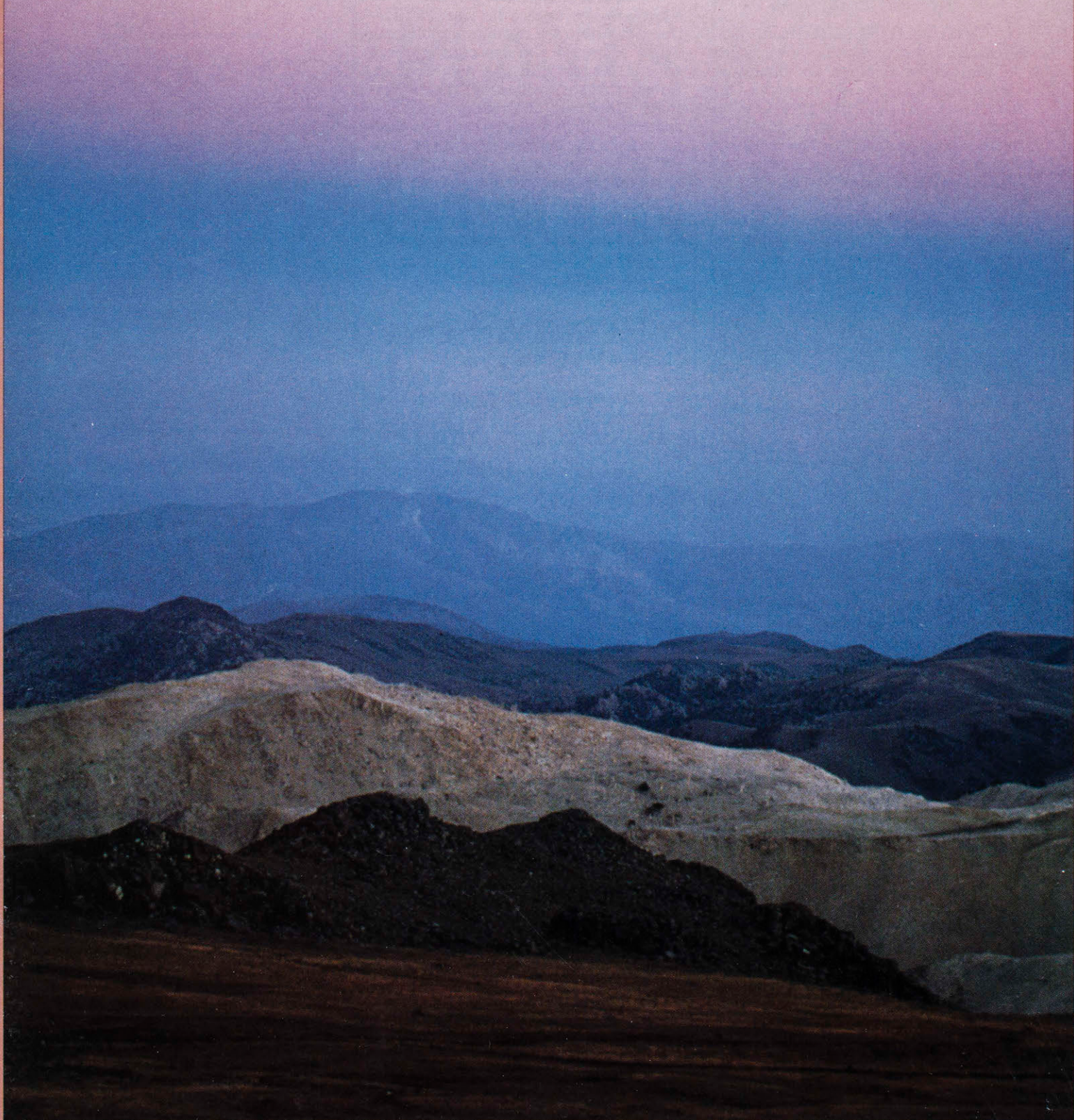


TERRA

THE NATURAL HISTORY MUSEUM OF LOS ANGELES COUNTY

VOL. 23, NO. 3 • JANUARY/FEBRUARY 1985



CURATORS & COLLECTIONS



RICHARD C. BRUSCA

Dr. Richard C. Brusca is our new Curator of Invertebrate Zoology. Dr. Brusca received his Ph.D. in 1975 from the University of Arizona; he received his undergraduate degree from the California State Polytechnic University at Pomona, and a Master's degree from California State University at Los Angeles. From 1974 to 1984 he taught at the University of Southern California, where he was also Curator of Crustacea at the Allan Hancock Foundation. In 1982 and 1983 he was Acting Chairman of the Department of Marine Invertebrates at the San Diego Natural History Museum. His work is focused on the systematics, ecology, biogeography, and evolution of Crustacea, with particular interest in isopods. He has done extensive field work in Southern California, Central America, and Mexico. His scientific papers on isopods and other topics in marine biology are numerous, and he is the author of the well-known handbooks *Common Intertidal Invertebrates of the Gulf of California* and *A Naturalist's Seashore Guide* (the latter coauthored with his biologist-brother). Dr. Brusca and his wife Anna Mary have two children.



SARAH B. GEORGE

Originally from Seattle, Washington, Sarah George, the museum's new Assistant Curator of Mammals, first became interested in mammals while working at the Natural History Museum at the University at Puget Sound as an undergraduate. She subsequently was hired on a National Science Foundation grant by Fort Hays State University in Hays, Kansas. There she conducted research on the systematics of short-tailed shrews (*Blarina*) and completed a Master's degree in 1980. She pursued her interest

in the shrew family by doing a doctorate on a genus (*Sorex*) with a worldwide distribution. Her research took her to Finland, India, Japan, Canada, and throughout much of the United States. Dr. George finished her Ph.D. at the University of New Mexico in 1984. Her future research interests lie in examining systematic relationships among western species of shrew and in studying the biogeographic history of mammals in the Pacific Northwest.

KATHY TALLEY-JONES

Kathy Talley-Jones joins the Publications staff from the computer publishing world, where she was Associate Editor of *Softalk for the IBM PC*, now defunct. Prior to that she worked for Sage Publications, Goodyear Publishing Company, and ABC-Clio in Santa Barbara. She graduated from the University of Texas, Austin, in 1977. She has long been interested in natural history, and she and her husband John share living quarters with two hibernating desert tortoises, a red-eared slider, a box turtle, two parakeets, a goldfish, and some guppies.

HENRY ANSON WYLDE 1908-1984 RUSSELL J. SMITH 1906-1984

Henry Wylde and Russell Smith, both of whom contributed many years to the museum, died of heart attacks within a week of one another early last October.

Mr. Wylde was hired in 1924 to work with the Rancho La Brea collection, and over the years he became an expert in field, research, and exhibit techniques. He studied at Otis Art Institute and traveled to European museums under a Guggenheim fellowship, preparing himself to design history and anthropological exhibits. When the Division of Exhibitions was established in 1941, Mr. Wylde was appointed chief of the division, a position he held until his retirement in 1967. During this time he and his staff designed and installed over five hundred exhibits.

Mr. Wylde is survived by his wife Hildegard Howard, an avian paleontologist and former chief of the combined science division.

Russell Smith began his work at the museum in 1931 as curator of the Junior Museum. He graduated from the University of Southern California and did some graduate work at the California Institute of Technology. When the Division of Education was formed in 1941, Mr. Smith

(Continued on page 31)

TERRA

THE MEMBERS' MAGAZINE
OF THE NATURAL HISTORY MUSEUM
OF LOS ANGELES COUNTY
AND THE PAGE MUSEUM
OF LA BREA DISCOVERIES

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COVER

Twilight in the White Mountains, California, 1977; photograph by Galen Rowell. Mountain Light, an exhibit of Mr. Rowell's photographs, is on display in the Director's Gallery of the Natural History Museum through April 15, 1985.

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PLANTS *against* CANCER

by WILLIAM A. EMBODEN

It was the venerable Hippocrates (460–377 B.C.) who first removed sickness from the province of religion and differentiated categories of diseases. Prior to his time sickness was thought of as a single great disease, and the various symptoms were taken not as indicators of a specific kind of illness but as part of a larger, more general malaise.

Many basic works on subjects such as cell division suggest that any aberrant cell division or irregular mitosis is a form of cancer. This sort of misinformation certainly does not help to clarify the conditions we characterize as cancers. Similarly, perhaps in a few years hence we will look back on this century's attitudes toward "cancer" and wonder that we did not see it sooner as the many diseases it is. In contrast, even in some of the basic compendia of folk medicines we find distinctions made between necrotic cancers and proliferating tumors.

Several hundred different types of cancer are known. They are identified by abnormal cells that begin to grow rapidly in a seemingly uncontrolled fashion. Necrosis results from invasive or intrusive growth or cells that have inadequate genetic material that keeps the cells' normal functions from taking place. Five basic types of cancer are generally recognized:

Leukemia: Changes in blood-forming tissues lead to an excess of white blood cells, many of which are abnormal.

Teratoma: Embryonic cells, usually in the testes or ovaries, that grow independently and uncontrollably.

Melanoma: Tissue that is usually black, such as a mole, often exhibiting rapid metastases. These are most often found on the extremities.

Carcinoma: Skin and related epithelial tissues proliferate. These are often found in the lining of the stomach and intestine.

Sarcoma: Arises in the body's connective tissue and includes muscle, cartilage, bone, fiber, and lymph and fatty tissues.

Possibly 1.5 million people now living in the United States have been "cured" of cancer, although precise numbers are impossible to determine because cancer statistics change rapidly, vary from one part of the country to another, and are uncertain when the term "cure" is introduced. However, many of these cures may be attributed to plant research and its burgeoning number of promising chemicals.

FOLK REMEDIES FOR CANCER

It is often difficult for the scientifically sophisticated to accept that folk remedies employing plants can successfully treat diseases that still resist the modern pharmacopoeia. Nonetheless, major screening programs are now under way in the United States and most other countries of the world, notably the U.S.S.R., China, and Japan, to find plants with anticancer properties. The search is fraught with problems and paradoxes. For example, why do plants in the same family have some members that are carcinogens or cocarcinogens and also contain representatives that effectively arrest cancers? The National Cancer Institute and the American Cancer Society have funded research projects to facilitate an understanding of just such problems, and they have supported an ongoing survey of tumor inhibitors from various sources—including plants.

The plants being screened and tested

vary widely in origin and in evolutionary relatedness—they were also selected to represent chemical diversity. Over thirty thousand species of vascular plants have already been tested for efficacy against a nasal-throat sarcoma and two types of mouse leukemia.

When one considers that flowering plants constitute about four hundred thousand species of the world's biota, the outlook for finding cancer cures is extremely optimistic. We must also keep in mind that plants provide many vitamins, such as A, C, and E, which serve as antioxidants helping to combat cancer of the gut. The concept of medicine and food being one was a generalized belief of the Menominee Indians; it is still applicable, although we continue to rely upon surgery, radiotherapy, and cellular immunogenicity while looking to flowering plants for chemicals that may play ever-increasing roles in combating cancer.

PLANTS IN CANCER THERAPY

BLOODROOT (*Sanguinaria canadensis*), a lovely spring-flowering plant found in the shade of beech and maple forests of eastern America, has been used by homeopaths for many years in treating cancers. When the stem of this short-lived herb of the poppy family is pulled from the ground, it draws with it a finger-sized rootstalk that breaks easily, spilling a blood red, acrid, and astringent juice. The fresh juice was used as face paint and as medicine by Indians in the northeastern United States. It must be remembered that North American Indians did not distinguish between "medicine" and "power." Thus, worn on the face, the bloodroot stain became an emblem of power or medicine and not merely a bizarre cosmetic. It has recently been demonstrated that an alkaloid extracted from bloodroot can allay certain cancers in mice. Bloodroot is also known as bloodwort, Indian paint, puccoon, or tetterwort.

LEAFY SPURGE (*Euphorbia esula*), a European plant now naturalized as a common weed in America. Not much credence was given to the folklore surrounding this herb (it was widely known as an astringent and used in ointments to clear up warts and corns) until a group of chemists found that an extract of the plant worked against leukemia in mice.

CROTON OIL (*Croton tiglium*), extracted from an Asian spurge, has had a widespread reputation as a cancer cure among those involved in plant medicinals. *Croton tiglium* was first described by the French naturalist Lamarck (1744–1829) who examined material from India and Ceylon where it was presumably in

active use. It has a very ancient history in southeast Asia as well and may be indigenous to that area. Oil distilled from *Croton* seeds found its way to Europe and America where it was widely used for several diseases, one of which was cancer. Recent assays of commercially available oils have revealed an active principle that inhibits leukemia in mice. Other studies, however, have demonstrated that by-products of the same oil act as cocarcinogens to produce cancer.

AUTUMN CROCUS (*Colchium autumnale*). Dioscorides (A.D. ca 50), a botanist and physician who traveled with Nero's army, recommended an extract of the bulb of the autumn crocus as a cancer treatment. At present an alkaloid isolated from this bulb is being used to treat chronic granulocytic leukemia.

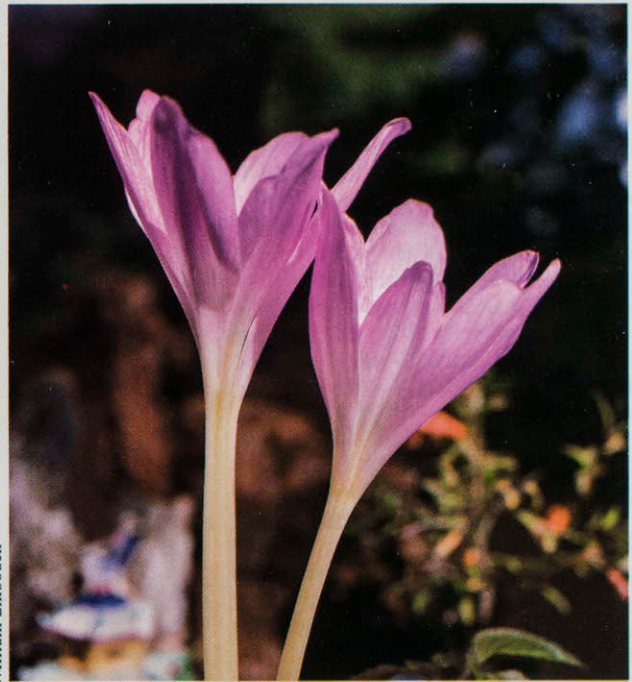
MISTLETOE (*Viscum album*) was prized by the Druids as a sacred plant and later by Christian monks who ate chips cut from this parasite as an act of humility. They believed that it was the plant that originally formed the wood for the cross of Jesus and could never again touch the ground; it assumed its present state as a degenerated parasite in retribution. For centuries the Russian people have been using mistletoe extracts as therapeutics against cancer. Swiss, German, and American researchers found in excess of 50 percent tumor inhibition in mice who were treated with juice expressed from this plant.

OLD WORLD BITTERSWEET (*Solanum dulcamara*) is found in the thickets and waysides of eastern temperate United States, the fleshy red berries hanging in clusters from a sprawling, slender climber. Not to be confused with the New World climbing bittersweet (*Celastrus scandens*), this weedy shrub came to us from Europe where it already had a considerable reputation as a medicant. Generally the roots and twigs were made into a tincture applied externally and internally for a host of diseases. Homeopaths have included tumors among the diseases treated by this plant. In 1875 Dr. O. P. Brown stated that this plant was to be regarded as significant as any in the plant kingdom. Perhaps he was correct. Bittersweet was important enough to be included in the *U.S. Pharmacopoeia* as *Extractum Dulcamarae Fluidum* and in the *Eclectic Materia Medica* as *Decoctum Solani* and *Extractum Dulcamara*.

We need to retreat far more than a century into medical formularies to find the first uses for bittersweet in medicine. The Greek physician Galen indicated its use against warts, tumors, and cancers around 150 B.C. Bittersweet is included in Russian folk medicine, and it is now under cultivation in the U.S.S.R. for use as a tumor inhibitor. The New World Bittersweet (*Celastrus scandens*) also



BLOODROOT
(*Sanguinaria*
canadensis)



AUTUMN
CROCUS
(*Colchium*
autumnale)



MISTLETOE
(*Viscum*
album)



OLD WORLD
BITTERSWEET
(*Solanum*
dulcamara)

contains agents active against cancers.

ORCHIDS. John Josselyn was one of the earliest simplers, or botanical physicians, roaming around America. In the late seventeenth century he recorded in his notebooks seeing a "wanton woman" (witch) making a brew using orchid roots to "procure lust."

Orchids have long fascinated humankind as medicants—we may trace records of their use back to the earliest Chinese herbals and pharmacopoeas, where they are recommended as cures for a variety of complaints, including tumors, and as promoters of longevity. The tenacity of the cane orchid, *Dendrobium*, inspired the Chinese, who dried pieces and sold them as a remedy for diseases of age including tumors. Investigations of *Dendrobium nobile* by both American and Japanese scientists in recent years have reaffirmed the Chinese contention: extracts from the cane showed marked effects in diminishing tumors.

PERIWINKLE (*Vinca* and *Catharanthus*). It was a common belief in Europe that sorcerers could make themselves invisible with the "receipt for fern seed" (although ferns have no seeds) or by means of the "sorcerer's violet" or periwinkle. The flower carried with it the connotation of evil; for example, when a man was destined for the gallows in renaissance Italy, he was forced to wear a garland of periwinkle on his brow. In England, however, a medieval formula stated "thou shalt pick this wort and thou shalt be clean of every uncleanness." An ointment prepared from the leaves worked into lard was supposed to cure ulcers and cancers.

When recent tests of the formidable sorcerer's violets of Europe revealed no cancer-preventing potential, the pink flowered periwinkle *Vinca rosea*, or more correctly *Catharanthus roseus*, was investigated to ascertain its possible uses against cancer. In inland Jamaica *Catharanthus roseus* was being used for diabetes by "balmyard healers," as the locals refer to those who practice indigenous herbal medicine. Word of the balmyard plant came to the laboratory, but several years of work showed that it did not reduce blood sugar—further, rabbits injected with the material died soon after.

Instead of ending their investigations, the research team analyzed the cause of death and found that the protective white blood cells were almost depleted, which suggested the plant's possible use in cancer therapy. It was later discovered that isolated components from *Catharanthus roseus* not only cured cancers in mice but protected the mice from subsequent challenges by the same tumor. This was an unprecedented discovery, and two of the plant's extracts were par-

Catharanthus roseus



Robert Gustafson

William Emboden



Camptotheca acuminata

Dendrobium
nobile



GARLIC
(Allium
sativum)



ticularly effective in treating children suffering from acute lymphocytic leukemia. A remission rate of 54 percent was achieved, and the extracted alkaloids cured 46 other kinds of malignancies.

Camptotheca acuminata, a tree introduced to the United States from China, does not have a spectacular appearance, and grows only in the warmer sections of this country. Little attention was paid to it by medical researchers until 1957, when the Cancer Chemotherapy National Service Center (a sector of the National Cancer Institute) screened some leaves sent from Chico, California. There was an indication of some antileukemic and antitumor activity, but the leaf supply was limited and the results were inconclusive. More leaves and twigs supplied in 1961 were very disappointing; however, fruit and twigs did give some significant results in a test highly predictive with respect to anticancer activity in humans. Subsequently an entire limb was removed from one of the two best known trees at Chico (then possibly the only two *Camptotheca* trees growing outside China).

Cutting down one of the trees for massive screening and losing the seed crop was out of the question. Word was sent throughout the West Coast to report the existence of any *Camptotheca* that might still be alive. A host of avocado trees were reported since the plant sought looks much like the avocado when out of fruit. Finally, nineteen trees were located, but there were still problems. Massive screening would require the sacrifice of these trees and perhaps bring an end to the existing plants outside the interior of China, which at that time was closed to the West.

The plant introduction station at Chico started a crop of seedlings in 1963, and by 1964 their establishment was relatively certain, so that larger, fifteen- to thirty-year-old trees could be sacrificed. From the wood an anticancer agent was isolated that inhibits the formation of DNA in very active cells prior to their division. Unfortunately the chemical also binds plasma proteins in the blood, making it a more toxic drug than was initially suspected. Since the drug accumulates in the peritoneal cavity, it was tested almost entirely on cancers of the gastrointestinal tract, lungs, liver, and nervous system. Despite these limitations and the toxicity, 50 percent tumor mass decrease in five of eighteen patients with advanced gastrointestinal cancers was reported and six others exhibited "evidence of objective response."

GARLIC (*Allium sativum*). One of the most frequently cited statistics concerning plants and cancer is the inverse correlation between cancer and geographical areas in which there is a high level of garlic consumption. Long revered as a pre-

ventive—Pliny the Elder (A.D. 23–79) believed it powerful enough to drive away serpents and scorpions—it has been cited as a cure for almost every diseased state that comes to mind. There is hardly an herbal that does not mention garlic's power to stay disease.

In 1957 it was discovered that cancerous mice, when injected with an enzyme extracted from garlic, showed no new tumor growth and remained alive for an additional six months, a time period that approximates one-quarter of a normal human lifespan.

Is it then any wonder that Hippocrates recommended that garlic be used as a treatment for uterine tumors? In ancient India, the early (A.D. 450) Bower Manuscript on herbs and health also recommended garlic as a cure for abdominal tumors. Recent geographical data suggest that cancer of the bowel is lowest where garlic consumption is the highest. Some physicians are now claiming success in treating malignancies by prescribing a diet high in raw garlic. Clearly garlic's ancient reputation has some validity in our time. The degree of its usefulness in

curing human cancer is still under investigation and may not be completely understood for some time yet.

MAYAPPLE (*Podophyllum peltatum*), used by the Penobscot Indians to treat cancers, entered the U.S. materia medica more than one hundred years ago with the assertion that a topical application would cure cancerous tumors, polyps, and cancerous granulations. The mayapple's resin found favor in Mississippi and Missouri at the end of the last century in the treatment of venereal warts. This drug has now become the primary drug used to treat the condition condyloma acuminata as neoplasms. Had it not been for the Penobscots, the plant and its powerful resins might well have escaped our notice. Since the extract is too toxic to be used internally, a derivative is substituted.

APRICOT (*Prunus armeniaca*). No plant product employed against cancer has provoked so much controversy as the seeds of apricots. Documents dating back to A.D. 502 show the Chinese used

apricot seed to arrest tumors. Oil expressed from these seeds was in popular use on superficial cancers in England in the seventeenth century. Those who support the use of laetrile, the extract of apricot seeds, believe that laetrile breaks down into cyanide upon contact with products of tumor cells. The issue remains controversial, with some data showing regression of malignant lesions and other data suggesting that there is little change in individuals subjected to such treatment.

Readers are advised that cancerous conditions should be treated only in consultation with their physicians. Many of the plants mentioned herein are extremely toxic.

William Emboden is Professor of Biology at California State University, Northridge, where he teaches a course in Medical Botany. He is also a Research Associate in botany at the Natural History Museum of Los Angeles, and a Research Fellow at The Botanical Museum of Harvard University.

PLANTS AGAINST CANCER

ACTIVE PRINCIPLES OF PLANTS DISCUSSED

Common Name	Genus and Species	Active Principles
Bloodroot	<i>Sanguinaria canadensis</i>	Sanguinarine & Protopine
Leafy Spurge	<i>Euphorbia esula</i>	Uncertain
Croton (purging croton)	<i>Croton tiglium</i>	Crotopoxide
Autumn Crocus	<i>Colchium autumnale</i>	Colchicine
Mistletoe	<i>Viscum album</i>	Uncertain
Bittersweet	<i>Solanum dulcamara</i>	Dulcumarin & beta solamarine
American bittersweet	<i>Celastrus scandens</i>	Uncertain
Cane orchid	<i>Dendrobium nobile</i>	Dendrobine
Madagascar periwinkle	<i>Catharanthus roseus</i>	Vinblastine & Vincristine
Camptotheca	<i>Camptotheca acuminata</i>	Camptothecin
Garlic	<i>Allium sativum</i>	Allicin
Mayapple	<i>Podophyllum peltatum</i>	Podophyllin & Podophyllotoxins
Apricot	<i>Prunus armeniaca</i>	Amagdylin, which releases hydrocyanic acid

MILLIONS *of* MONARCHS

by JIM ZUCKERMAN

Photographs by the author

The wind rustled through the trees and filled the high mountain forest with a fullness of sound that is truly rejuvenating to the human soul. But with closer observation I noticed that the tree branches weren't swaying, the ground shrubs were motionless, and I felt no wind on my face. I suddenly realized that the sound of moving air was caused by the flight of millions of Monarch butterflies as they filled the sky and darkened the sun.

The site was one of the few overwintering locations for Monarch butterflies (*Danaus plexippus*) that migrate from the eastern and midwestern portion of the United States and Canada to Mexico's Sierra Madre Mountains. I was part of a research team headed by Dr. William Calvert and sponsored by Earthwatch, a nonprofit organization that helps fund scientific projects in many disciplines around the world. The major goal of the research at hand was to identify the ecological and meteorological factors most important in determining Monarch population size. The long-range goal, as Dr. Calvert stated, is to "develop a model whereby Monarch population size can be predicted." This model will allow scientists to determine dangerous declines in Monarch population and start setting appropriate regional conservation measures in motion.

Over the course of two weeks, our ten-person research group visited a total of four colonies, all located in the state of Michoacán about sixty miles west of Mexico City. The sites occur in alpine forests just above 10,000 feet where the air is cool and moist. This moisture is important because it protects the Monarchs from desiccation when they are immobilized by low temperatures. The forests are dominated by the *oyamel*



(*Abies religiosa*), a fir tree, some of which grow to ninety-five feet in height. Pine and cypress trees are also prevalent. The forest floor's dense understory, we later learned, is crucial to the survival of the butterflies because it helps retain the forest's ambient temperature.

During our initial briefing in Mexico City, followed by demonstrations in the field, Bill Calvert showed us what our tasks would be in accumulating data to aid his research. First, we were to map each colony to determine the area it covered in hectares. The density of the trees in the forest was then measured, as well as the relative packing of the butterflies on the tree crowns and trunks. Mortality factors are crucial to understanding the overall health of the population, so we needed to sample fallen Monarchs in random plots within the colonies and attempt to determine the cause of death. We found that many were obviously victims of attempted predation by birds, but others had died without apparent cause. We needed to conduct sex ratio studies and, finally, determine the altitude for each site and the azimuth it faced. The azimuth provides an indication of the amount of exposure to direct sunlight the butterflies have—the cold-blooded butterflies must warm up enough in the sun's rays before they can fly to nearby streams to drink water.

Once we were at the Monarchs' overwintering sites, the most disturbing aspect of the research was the knowledge that many of these exquisite insects were being killed by our presence. There were so many butterflies on the ground—conservatively tens of thousands—that it was impossible not to step on some of them. All of us were extremely careful to avoid as many as humanly possible, but in most instances it was

We camped approximately two miles from one of the major colonies. The trail was often shrouded in fog.



*Opposite page:
When shaded from
sunlight, Monarchs
rest with their
wings folded above
their bodies.*

*Below: As soon as
the sun strikes the
resting butterflies,
they open their
wings to absorb the
warmth.*

*Inset: Hundreds of
Monarch butterflies
cling to fir tree
branches in the El
Pelon colony near
Zitacurro, Mexico.*



like trying to avoid stepping on grains of sand at the beach. All of us loved the fact that we were working toward the ultimate good of the population, that the knowledge we were helping to gather about this astonishing phenomenon of nature would eventually benefit the species. But a species consists of individuals, and it hurt us to kill those that happened to be underfoot.

Much of the work the Earthwatch team performed required stamina and determination. The overwintering sites were usually in rugged terrain, thick with underbrush, and located on steep slopes. The elevation made us feel our exertions more acutely as we walked up and down the face of the mountains, and the rapid temperature fluctuations seemed to affect us more than the cold-blooded butterflies. But nobody complained.

After each day's work was completed, we returned to our camp. Sometimes this meant a two-mile hike; other days we braved driving some of the roughest roads I've ever seen and arrived back at camp with scrambled brains. We all contributed to the functioning of the home base. During and after meals (the variety of food was excellent thanks to trip coordinator Betty O'Berry—a favorite was eggs a la wind-blown ashes), Bill would answer questions and describe the fascinating behavior and life cycle of the Monarch butterfly. The most intriguing aspect of this beautiful creature certainly has to be the dynamics of the migration itself.

The Monarchs' migration is remarkable for many reasons. First, a delicate creature weighing about half a gram must fly south as far as 2,400 miles to the final overwintering site. Its fragile wings are often torn or shredded, yet they sustain the butterfly for the entire journey. Second, none of the insects have ever been to the colony location before they arrive en masse. The previous spring, when their ancestors flew north to eastern United States and Canada, they mated, laid eggs, and died before reaching their destination. About three weeks later those eggs matured into adult Monarchs who continued the journey north. Throughout the summer, several short-lived generations (from three to five weeks each, depending on temperature and local meteorological conditions) build the population to immense numbers. By mid-September the Monarchs congregate locally and then begin their migration to Mexico. Those individuals who fly south are several generations removed from the ones that flew north six months earlier, and individual butterflies from Canada and intervening localities go all the way to Mexico. The annual migration is thus a very complex behavior pattern in which learning plays no role.

How do the butterflies find their way

Female Monarch. Dislodged from her position on the tree trunk, a female Monarch rests on the understory of the forest trying to raise her body temperature enough to

initiate flight. When trapped on the forest floor by cool ambient temperatures, Monarchs are more vulnerable to such predators as rodents and wandering livestock.



over such great distances? Do they use the sun, or the earth's magnetic field, or the polarization of light in the sky? Researchers think it could be a combination of all these, for if all the Monarchs flew to Mexico using the same flight vector, how could individuals from both Maine and Wisconsin end up in the same location? Answers are yet to be forthcoming.

We also discussed the evolution of migration. The Monarch feeds off various species of milkweed. Over the past several million years this plant underwent an evolutionary diversification across North America that produced no fewer than 108 species in the genus *Asclepias* alone. This smorgasbord of milkweed represented a vast potential food supply because the plants produce poisons that are repellent—if not lethal—to most vertebrates. This confers protection on the Monarchs, which store these poisons in their bodies without adverse effect. The danaid butterflies (the family that

includes the Monarch), however, evolved in tropical climates, and no stage of the metamorphosis—egg, larva, chrysalid, or adult—can survive the prolonged freezing temperatures that occur in temperate North America. Having developed the ability to migrate, perhaps by following the northward dispersal of the milkweed yard by yard, mile by mile, over ten million years, the Monarch is able to exploit the North American summer food supply and then retreat southward to escape the excessive cold.

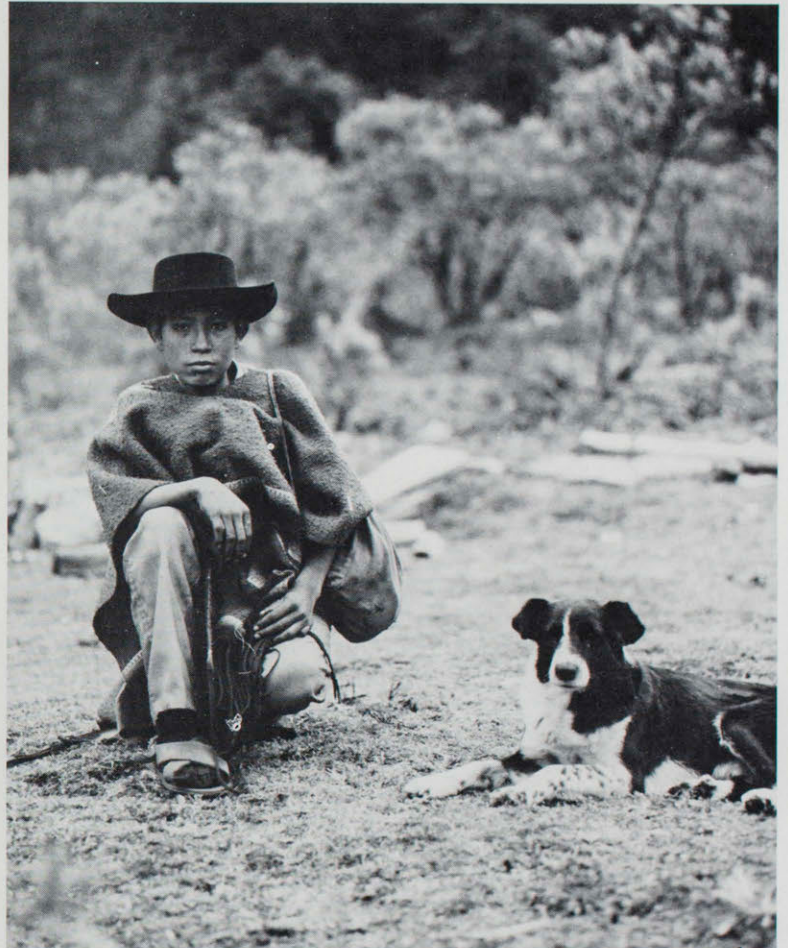
During the winter months the Monarchs are essentially dormant. Sometimes they can be seen drinking from a mountain stream or looking for nectar, but this montane coniferous community has few flowers in proportion to the enormous mass of butterflies, and there certainly aren't enough nectar sources to sustain the entire population. The tremendous amount of energy required to fuel such a strenuous migration, sustain life throughout the winter,

Dr. William Calvert and friend take a short break in the middle of the Rosario colony near the town of Ocampo, Mexico.



One of a small group of vigilantes, this young boy was hired, along with his father, by the Mexican government to protect the butterfly colonies from tourists and

local peasants. Mexican farmers resent the federal government's protection of mere butterflies. The dog protected our camp from the farmers' free-roaming cattle.



and then fuel the return flight comes from the large amounts of fat stored in their body tissues during larval development. An earlier experiment determined

that fat makes up, on average, 34 percent of the butterfly's dry body weight.

After two weeks, our stay in Mexico's transvolcanic belt of mountains was

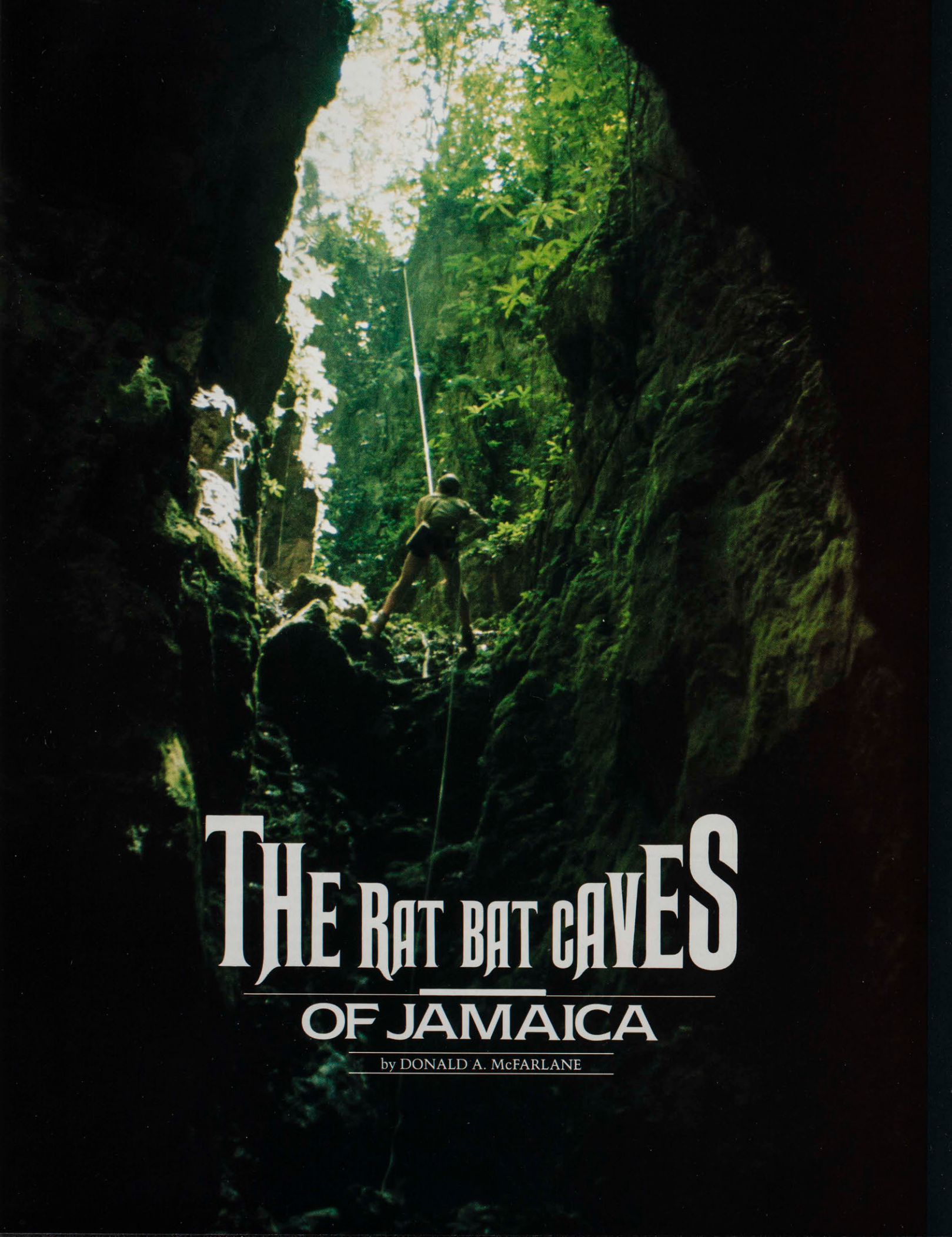
over. Still with me, though, was the memory of the whispering of Monarch wings in the forest. The butterflies had been everywhere! They had covered the trees, filled the sky, carpeted the ground, and had even landed on my photographic equipment. It was an overwhelming spectacle—in a glance I had seen 10 million butterflies. They had shimmered brilliant orange in the sunlight, waiting for the days to lengthen into spring before beginning their long return journey northward.

EARTHWATCH

Earthwatch, which sponsored this research on the Monarchs of the Sierra Madre, backs field expeditions in ornithology, primatology, ethnomusicology, archeology, marine biology, paleontology, and many other fascinating disciplines. The projects are open to anyone who enjoys working and contributing to a worthwhile encounter and who has an insatiable curiosity about the world around us. The share of costs each of the volunteers pays to support the research is entirely tax deductible, making the projects enticing from a financial point

of view as well. From time to time Earthwatch has participated in fieldwork by museum curators: Julian Donahue has led two expeditions to Costa Rica and Dr. David Whistler has led one to Red Rock Canyon. At present Dr. Ralph Schreiber and Betty Anne Schreiber are heading a project at Christmas Island to study the seabirds that abandoned their nestlings—perhaps because of El Niño—in late 1982. Future expeditions will be announced in forthcoming issues of *TERRA*.

Jim Zuckerman is a professional photographer based on the West Coast. He has taught photography at UCLA and Kent State University and leads photography tours to many parts of the world. He has had many articles published in photography magazines. His range of photographic interests include ethnic dance, classic cars, foreign festivals, archeological sites, photomicrography, and wild life.

A photograph of a person rappelling down a dark, mossy cave wall. The person is seen from behind, wearing a light-colored shirt and dark shorts, and is holding a rope that extends upwards. The cave walls are covered in green moss and vegetation. At the top of the cave, there is a bright opening where sunlight is streaming in, illuminating the dense foliage outside. The overall atmosphere is mysterious and adventurous.

THE RAT BAT CAVES

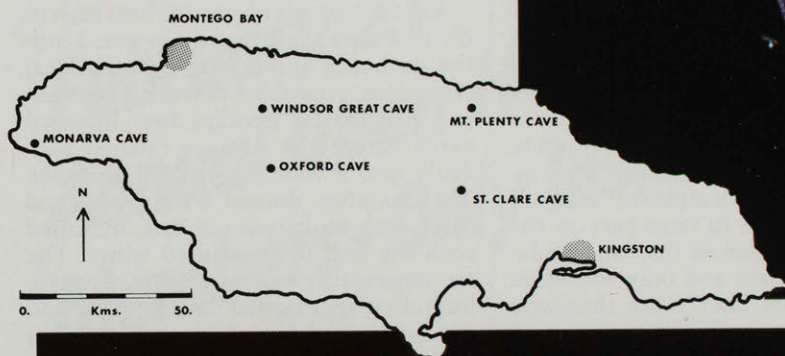
OF JAMAICA

by DONALD A. McFARLANE

Opposite page: A member of the author's 1977 expedition rappels into a previously unexplored sinkhole in the central highlands of Jamaica. These dimly lit entrances are favored roost sites for the Jamaican Fruit-Eating Bat.

Right: The Jamaican Fruit-Eating Bat (*Artibeus jamaicensis*) is a common inhabitant of large caves and hollow trees throughout the tropical forests of South America, Central America, and the Caribbean. The triangular projection on the nose is a device to direct the bat's echolocation signals.

Below: The Jamaican Fruit-Eating Bat specializes in feeding on figs and similar tropical fruits. Figs weighing as much as one-quarter of the bats' body weight are plucked from the trees and carried hundreds of meters to feeding roosts.



Jamaica is not an unusual tourist destination—last year thousands of Americans vacationed on the island. However, only a handful of these people ever leave the ribbon of tourist development along the north and west coasts and venture into the interior of the island. Here a fortuitous combination of geology and climate has created an area of immense interest to geomorphologists, cavers, and biologists alike.

Much of Jamaica sits upon a massive bedrock of limestone. In the center of the island, however, a spine of impermeable metamorphic rock has pushed up, creating an ideal watershed to trap the tropical rains that sweep in from the northeast. This heavy rainfall feeds substantial streams and rivers, the largest of which meander through forests and banana plantations until they reach the limestone boundary. Here they have carved their way underground and traverse the island in huge cave passages, often only partially explored by man, before finally resurfacing as "blue holes" (small, deep ponds) and less spectacular springs that feed the coastal streams and waterfalls so popular with postcard photographers.

Over the passage of tens of thousands of years, sea-level fluctuations and the erosive effects of the water have lowered the water table, leaving some of the trunk passages dry while the subterranean rivers find deeper courses. Elsewhere, sinkholes that once channeled tributary streams into the earth may also have dried, leaving much of Jamaica resembling an immense swiss cheese.

A handful of the more voluminous of these cavities are today home to uncounted legions of bats—or "rat-bats" as local parlance prefers. My own introduction to these caves was in 1977 as part of an expedition charting the unexplored courses of some of the underground rivers. More recently, Dr. Kenneth Stager and myself have begun what we hope will be a series of visits to the more important of Jamaica's rat-bat caves.

Jamaica's bat fauna is unusually varied—some twenty-one species are known. Several are apparently rare and their ecology is almost completely unstudied. They include an endemic genus of fruit bat, *Ariteus*, which is known from only a few live captures and skeletal material accumulated in owl pellets. The endemic species *Eptesicus lynni* is even more poorly known; only a few specimens have been collected since its discovery in 1945. Museum collections also contain a few curious specimens that may not actually be found in Jamaica—a single specimen each of the enormous carnivorous bat *Vampyrus spectrum* and the omnivorous *Carollia perspicillata*, and two specimens of the fruit-eating species *Sturnira lilium*. Whether these specimens represent accidental migrants, errors in labeling, or

Thigh-deep pools of fetid water and liquid guano cover the passage floor, and the walls are a living carpet of scavenging cockroaches, cave crickets, and millipedes.

rare species still to be rediscovered cannot yet be decided.

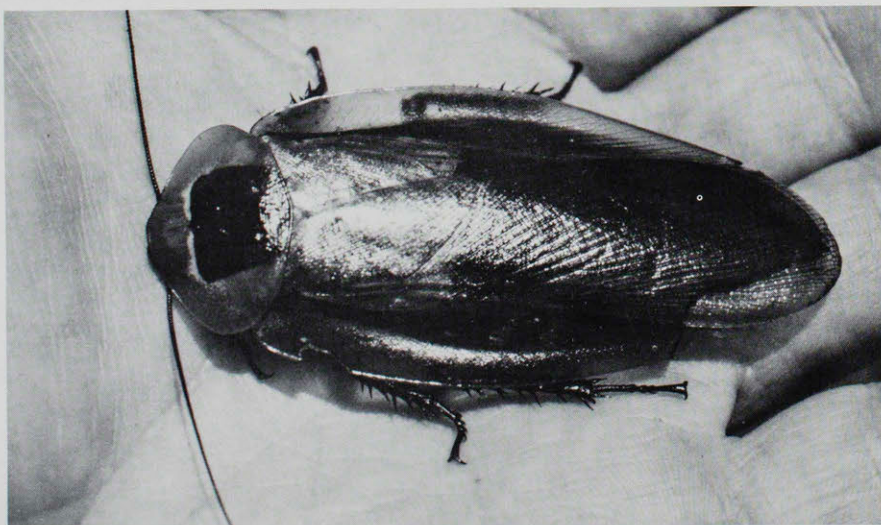
Not all of Jamaica's bats live in caves, but at least fifteen species do so. Nor do all of Jamaica's thousand documented caves have bats, but a recent inventory showed that approximately 17 percent were being used by bats. Most of these caves host only small numbers of bats, but in a few cases populations run into the tens of thousands. Large guano deposits accumulate on cave floors beneath these bats, and this is often profitably mined locally as a rich fertilizer. Of more interest to the biologist, the guano forms the basis on which a whole miniature ecosystem of insects and other invertebrates depend. The complexity of these communities hangs in large part on the size and composition of the bat population, their ultimate and only source of food. Caves that host more than one species of bat typically have more varied invertebrate communities because of the differing nature of the guano deposited.

In some guano caves, excavations have unearthed rich deposits of bat and other vertebrate bones. The uppermost layers reflect the modern fauna, including such post-Columbian introductions as the ubiquitous brown rat and house mouse, and the mongoose introduced to control them. Deeper layers have revealed a

great variety of extinct species, including the bat *Tonatia* found today only in South and Central America, and a species of fruit bat *Brachyphylla*, which exists today on Hispaniola (Haiti and Santo Domingo) but has apparently died out in Jamaica. Evidence has also been found of a fossil monkey and several rodents of South American affinities.

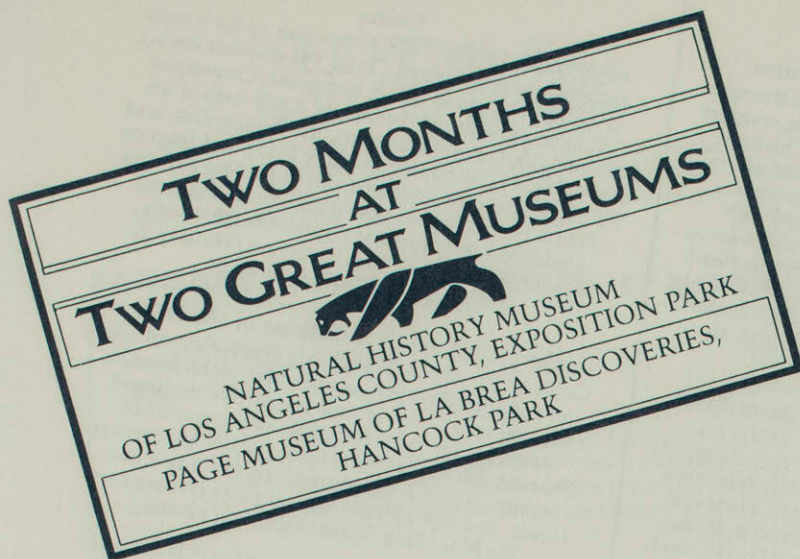
At the western tip of Jamaica, hidden in a doline (or sink) shadowed by a small banana grove, lies a superficially unimpressive sinkhole. This cave is well known locally as the Monarva Rat-Bat Cave. In August 1983 the resident farmer proved only too willing to provide a rickety, eight-foot, three-rung improvised ladder for its exploration. The large crowd that accompanied us needed only a few Molotovian lamps constructed from Pepsi bottles filled with gasoline and stoppered with rag wicks to begin the descent.

As small groups of startled bats high in the roof took flight and disappeared into the darkness ahead, our pyromaniacal procession scrambled down a steep canyon passage for perhaps four hundred yards before the passage opened suddenly into a wide, low-roofed chamber. The chamber, floored with guano and filled with multitudes of bats, hummed with the beat of uncounted wings. The air temperature was noticeably elevated, humidity approached 100 percent, and my quickened breathing indicated an uncomfortably high carbon dioxide concentration. Considerable exertion and spelean acrobatics netted but a single bat for identification, but moments later a second specimen obliged us by colliding with my chest and falling stunned to my feet. Back at the entrance, I found that the two bats were of different species. The first was a Funnel-Eared bat, *Natalus micropus*, which has been infrequently recorded from Jamaica, while



The Giant Death's Head Cockroach (*Blaberus*). These are common denizens of caves throughout the neotropical region, where they scavenge organic refuse deposited by bats and other animals.

Charles L. Hogue



JANUARY/ FEBRUARY 1985

CALENDAR OF EVENTS

February 21 Annual Open House Members-Only Insiders' Tour

Come explore your Natural History Museum... and see our latest finds.



It's your chance to take a members-only, behind-the-scenes adventure... tour undisplayed treasures... visit with curators in their laboratories and research areas... and meet with celebrity hosts.



Docent tour guides will be available to direct you to all the off-limits places and storage areas and share their knowledge of the museum's hidden mysteries.

You can also be eligible to win an exciting trip for two to China, traveling with a museum group. Just buy one or more gift memberships between now and February 21, 1985. You'll receive one Trip-to-China raffle ticket for each gift membership you purchase. Gift memberships mailed to the museum must be received no later than February 20th to be eligible for the raffle. Just use the attached form, and be sure to fill out the raffle ticket in your own name. You may also buy gift memberships at the Open House until 7:00 p.m. The drawing will be held at 8:00 p.m. in the Main Foyer of the museum.



Winners need not be present to win. Museum and Los Angeles County employees and their immediate families are not eligible to enter the drawing.

Please R.S.V.P. by phoning the museum Membership Office (213-744-3426) to let us know how many people will be in your party.

To give a gift membership, please complete the Gift Membership card and Raffle Ticket and return to:

Natural History Museum of Los Angeles County
Membership Office • 900 Exposition Blvd. • Los Angeles, CA 90007

We will send a gift announcement in your name to each of your gift recipients, along with their membership card and an invitation to the members-only Open House.

The raffle ticket attached with your name will be entered in the drawing for a free trip to China for two! Each gift membership entitles you to one raffle ticket.

GIFT MEMBERSHIP FOR

Name _____

Address _____

Phone _____

☐ Enclosed is my check for the amount indicated at the right above.

☐ Please charge to my VISA/MasterCard/American Express

Account # _____ Expir. Date _____

Signature _____

Type of membership:

- ☐ Individual (\$20)
☐ Senior Couple (\$20)
☐ Individual and guest or Family (\$30)
☐ Contributing (\$50)
☐ Patron (\$100)

Please send card indicating this gift is from _____

This gift is

- ☐ a new membership
☐ a renewal

RAFFLE TICKET The above gift is from:

Name _____

Address _____

Phone _____

Membership Number _____

GIFT MEMBERSHIP FOR

Name _____

Address _____

Phone _____

☐ Enclosed is my check for the amount indicated at the right above.

☐ Please charge to my VISA/MasterCard/American Express

Account # _____ Expir. Date _____

Signature _____

Type of membership:

- ☐ Individual (\$20)
☐ Senior Couple (\$20)
☐ Individual and guest or Family (\$30)
☐ Contributing (\$50)
☐ Patron (\$100)

Please send card indicating this gift is from _____

This gift is

- ☐ a new membership
☐ a renewal

RAFFLE TICKET The above gift is from:

Name _____

Address _____

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Membership Number _____

MATCH YOUR MEMBERSHIP

Match your membership—and receive an Olympic Commemorative Poster!

You can double, even triple your museum support without spending a penny. How can you do this? The companies listed below have agreed to match employees' membership donations (or any museum contribution!). For the museum to receive these matching funds, simply complete a matching gift form available from your company's personnel department and return it with your membership renewal. If you are not employed by one of the companies listed below, check with your personnel office to see if they will match your membership.

In appreciation for your company's gift, a commemorative poster will be waiting for you at the museum's Membership Office. The poster is a color reproduction of the July 1932 Game & Gossip magazine cover, "The Olympic Girl."

Or...Upgrade your membership—and receive an Olympic Commemorative Poster! If your company can't match your gift, you can still receive the Olympic Commemorative Poster mentioned above. Just increase your membership donation to the next member category when you renew. Then come into the museum Membership Office to pick up your poster.

COMPANIES THAT INCLUDE MUSEUMS IN MATCHING FUND PROGRAMS

- Allied Chemical Corp.
American Brands, Inc.
American Express Co.
American Telephone & Telegraph Co.
AMF Inc.
The Andersons
Armco Inc.
Atlantic Richfield
Automatic Data Processing
Avon Products, Inc.
The J. E. Baker Co.
Bank of America Corp.
Barber-Colman Co.
Bernd Brecher & Assoc. Inc.
Best Products Co.
The Boeing Co.
Boston Edison Co.
The Boston Globe
Newspaper Co.
Brakeley, John Price
Jones Inc.
Brown Group
Brunswick Corp.
Buffalo Color Corp.
Bucyrus-Erie Co.
Bunge Corporation
Butler Manufacturing Co.
Carter Hawley Hale
Stores, Inc.
Caterpillar Tractor Co.
Celanese Corp.
The Charter Company
The Chase Manhattan
Bank, N.A.
Chemical Bank
Chubb & Son, Inc.
Citicorp & Citibank, N.A.
Cities Service Co.
The Coca-Cola Co.
Colonial Penn Group, Inc.
Consolidated Natural
Gas Co.
Consolidated Paper, Inc.
Continental Group Inc.
Consolidated Foods Corp.
Continental Illinois National
Bank & Trust Co.
Frederick W. Cook & Co., Inc.
Cooper Industries, Inc.
Corning Glass Works
Customized Computer
Systems, Inc.
CPC International Corp.
Dart Industries, Inc.
Deluxe Check Printers, Inc.
Del Monte Corp.
Digital Equipment Corp.
E-B Industries
Emerson Electric Co.
Emhart Corp.
Ensign-Bickford Foundation
Equitable Life Assurance
Society of the U.S.
Ethicon, Inc.
Exxon Corp.
Federated Department
Stores, Inc.
Fiduciary Trust Co.
Field Enterprises, Inc.
Fireman's Fund Insurance Co.
First & Merchants National
Bank
- First Bank System, Inc.
Fluor Corp.
Funderburke &
Associates, Inc.
Freeport Minerals Co.
GATX Corp.
Gary Energy Corp./Samuel
Gary Oil Producer/The
Piton Foundation
GenRad, Inc.
Gilman Paper
BF Goodrich Co.
GK Technologies, Inc.
Great Northern
NeKoosa Corp.
Gulf & Western
Industries, Inc.
Gulf Oil Corp.
Harris Corp.
Harris Trust and Savings
Bank
Hartford Steamboiler
Inspection & Insurance Co.
H.J. Heinz Co.
Household International
Houston Natural Gas Corp.
IU International Corp.
Illinois Bell Telephone
Illinois Tool Works Inc.
Indiana Bell
International Business
Machines Corp.
International Minerals &
Chemical Corp.
Jefferies & Co., Inc.
John Hancock Mutual Life
Ins. Co.
Johnson & Higgins
Johnson & Johnson Family
of Cos.
Josten's Inc.
Kemper Group
Kennametal, Inc.
Kimberly-Clarke Corp.
Koppers Company, Inc.
Lever Brothers Co.
Levi Strauss & Co.
Lincoln National Corp.
Little, Brown & Co.
The Lubrizol Corp.
R. H. Macy & Co., Inc.
Maguire Oil Co.
Martin Marietta Corp.
McCormick & Co., Inc.
McDonald's Corp.
McGraw-Hill, Inc.
The Mead Corp.
Meadville Corp.
Merit Oil Corp.
Millipore Corp.
MITE Company
Mobil Oil Corp.
Monsanto Co.
Montgomery Ward & Co., Inc.
Morgan Guaranty Trust Co.
of N.Y.
Morton Thiokol, Inc.
MTS Systems Corp.
Murphy Oil Corp.
NCR Corp.
NL Industries, Inc.
National Health & Welfare
Mutual Life Ins. Assn.
- The Northern Trust Co.
Northwestern Bell
Norton Co.
Penn Central Corp.
Pennzoil Corp.
Peoples Energy Corp.
PepsiCo Inc.
Pfizer, Inc.
Phelps Dodge Corp.
Philip Morris, Inc.
Pittway Corp.
Playboy Enterprises, Inc.
Pogo Producing Company
Polaroid Corp.
PPG Industries Inc.
PQ Corp.
Quaker Oats Co.
Quaker Oats Co.
Quaker Chemical Corp.
Ramer National Bank
Ralston Purina Co.
Arthur D. Raybin Assoc., Inc.
Rexnord Inc.
R. J. Reynolds Industries, Inc.
Rockefeller Center, Inc.
Ross Johnston &
Kersting, Inc.
RYCO Division,
Reilly-Whiteman, Inc.
SAFECO Insurance Cos.
The St. Paul Cos., Inc.
Scott Paper Co.
Joseph E. Seagram
& Sons, Inc.
Security Pacific Corp.
Shaklee Corp.
Shugart Assoc.
The Signal Companies Inc.
Suburban Propane
Gas Corp.
Sun Company, Inc.
Tandy Corp.
Tektronix, Inc.
Tesoro Petroleum Corp.
Texaco
Texas Eastern Corp.
Texas Instruments, Inc.
Tetron, Inc.
Time, Inc.
The Times Mirror Co.
The Toro Co.
Transamerica Corp.
The Travelers Insurance Cos.
TRW Inc.
William Underwood Co.
Union Oil Co. of California
Union Pacific Corp.
United Parcel Service
United States Fidelity &
Guaranty Co.
United States Gypsum Co.
United Technologies Corp.
United Virginia
Bankshares, Inc.
Valley National Bank of
Arizona
Vulcan Materials Co.
Warren-King Cos.
Waste Management, Inc.
The Washington Post
Wellington Mgmt. Co.
Westinghouse Electric Corp.
Xerox Corp.
Yarway Corp.

1985 Members' Travel Plan

The Hermitage Experience in Russia
February 17-24, 1985. Peter the Great's capital city houses the Hermitage, one of the world's greatest museums and a beautiful edifice in its own right. The tour focuses on the Hermitage, which contains masterpieces from the early Renaissance to the twentieth century; however, a historical overview of Leningrad and stops in Helsinki are also included. Special price: \$1098.

Central Mexico & Oaxaca
April 10-21, 1985. Join us for a special trip through Mexico's archaeological treasures with Dr. Frederick J. Bove, a specialist in meso-American civilizations. We will visit Central Mexico's most famous sites, including Teotihuacán, Tula, Monte Alban, and Mitla. Also included: the Aztec religious sanctuary of Malinalco, the magnificent temple of Quetzalcoatl in Xochicalco, and the beautifully painted frescos at Cacaxtla. Shoppers will find extraordinary bargains in the shops and native markets en route. \$1806, including air fare.

Colonial South Yacht Cruise
April 13-20, 1985. Sail with us through the heart of the Old South in the comfort of a cruise ship. We will visit historic ports, photograph graceful antebellum homes, and walk through showplace parks of ancient oaks covered with Spanish moss. The cruise will also take us into the exclusive resorts of Hilton Head and Saint Simon Island, as well as Savannah, Charleston, and other centers of the Colonial South. \$1579 and up, including air fare.

European Historical Garden Tour
June 12-July 3, 1985. Garden enthusiasts will love this tour accompanied by Mr. Robert Gustafson, the museum's Assistant Curator of Botany. Visits will be made to historical gardens in Rome, Florence, Venice, Paris, and London and environs. \$3008, including air fare.

Kenyan Safari
August 19-September 1, 1985. Explore some of the most breathtaking scenery in the world, from snow-capped mountains to lush river valleys, endless savanna plains to jungle forests. Travel with a natural history expert to Nairobi, Mount Kenya, Lake Nakuru, and Masai Mara. Optional trips are available August 16-20 to London and August 31-September 5 to Mombasa. From \$2730, including air fare.

Grand Canyon River Rafting
September 1-7, 1985. The Wilderness Studies Institute will lead this exciting trip on the Colorado River. Floating through the ageless Grand Canyon is an unforgettable experience, and many of those who went on this trip last year plan to join us again. The trip includes lectures on geology, archaeology, wildlife, and other fascinating aspects of the Grand Canyon. About \$500, including transportation.

China
September 13-29, 1985. Come join us for a truly exotic adventure through China! We will visit Beijing (Peking), Shanghai, Hong Kong, and Chongqing. Visit an agricultural commune, a silk factory, an oriental rug factory, museums, the Beijing Zoo, and more. We'll go shopping in Hong Kong and feast on Peking Duck. (The museum will be raffling two free tickets for this trip to new members and current members who purchase gift memberships at a drawing held at the Open House on February 22, 1985.) \$3799, including air fare.

Egypt and the Civilizations of the Nile
October 10-24, 1985. With our expert Egyptologist and accomplished archaeologist Dr. Nabil Swelim, we will travel back in time nearly five thousand years to visit the remarkable step pyramid of Pharaoh Zoser, the ageless stare of the mysterious Sphinx, and the temple remains of Karnak and Luxor. The trip includes an eight-day cruise down the Nile. From \$3491, including air fare.

Other trips tentatively planned for 1985 include Catalina Island in March, Alaska in May, Papua New Guinea in July, and more. Please call Becky Chapman at the Membership Office (213/744-3426) for more information.

LECTURE

WRANGELL/ SAINT ELIAS NATIONAL PARK

You are invited to a very special presentation about a very special place on January 23, 1985.

The Wrangell/Saint Elias National Park in Alaska is the largest park of any kind in the United States. The United Nations has designated the park as a World Heritage Area, and it is considered one of the world's outstanding wilderness resources. It contains 12.5 million acres, largely unknown and unexplored.

Wrangell/Saint Elias National Park's spectacular scenery includes the largest concentration of mountain peaks over 15,000 feet in North America. Wildlife abounds—Dall sheep, bear, moose, and wolf all inhabit the area. The area also has great historical significance: it contained one of the most populated areas of Alaska during the heyday of copper mining, now the largest mining ghost town in the world.

Saint Elias Alpine Guides will present a three-screen slide show and talk on this unique area at the Natural History Museum on January 23, 1985, from 7:30 to 8:30 p.m. in the Jean Delacour Auditorium. Time will be allowed for questions and talking with the guides after the presentation.

Museum members and the general public are welcome. Please R.S.V.P. by calling the Membership Office at 213/744-3426.

FREE FILMS AND GALLERY TOURS

In January and February the Tuesday film and gallery tour program will focus on the museum's American history collection. Films will begin at noon in the Jean Delacour Auditorium, and tours will start at the North entrance at 1:30 p.m.

JANUARY 8, 1985

FILMS 12 NOON

THE LOOK OF AMERICA 1750-1800

color

26 min

This beautiful Eames film shows us the richness and diversity of our historical heritage. Wilderness settings unchanged in 200 years blend with live action reenactments of craftsmen and settlers at work, giving us a sense of what life was like in early Colonial times.

THE WORLD OF FRANKLIN AND JEFFERSON

color

28 min

This film traces the careers of Benjamin Franklin and Thomas Jefferson, two men who helped shaped the course of American history. Focusing on their characters, philosophies, and accomplishments, the film sets the major events of each man's life against the cultural, social, and economic background of Colonial and Revolutionary America. Made in cooperation with the Metropolitan Museum of Art and narrated by Orson Welles and Nina Foch.

TOUR 1:30 P.M.

THE AMERICAN: THIS NEW MAN

This gallery, which focuses on American history up to 1815, features exhibits on exploration, Indian and Colonial wars, and Colonial living and crafts. Artifacts on display include eighteenth-century weapons, a bell cast by Paul Revere, clothing belonging to Thomas Jefferson, and furnishings from early American homes.

FEBRUARY 5, 1985

FILM 12 NOON

AMERICA: GONE WEST

color

52 min

This segment of Alistair Cooke's America series deals with the westward expansion of the United States from 1800 to 1850. Commencing with the purchase of Louisiana in 1803, the film follows the Lewis and Clarke expedition to the Pacific, commerce on the major rivers, the displacement of the Indians west of the Mississippi, and the surge westward by the 49ers during the California gold rush. Produced by the BBC and Time-Life Films.

TOUR 1:30 P.M.

GROWTH OF THE NATION (1815-1865)

This recently opened hall traces a period of unprecedented growth, development, and opportunity in the United States using artifacts, dioramas, and period settings, including a "hands-on" key-touch telegraph, household possessions, and equipment used by immigrants on their journeys across the nation.

We Want You! All of You!

We're calling on all of you with a little extra time on your hands and a place in your hearts for the Natural History and Page Museums. The Membership Office needs your help...so join us in our upcoming membership campaign effort.

For more information on how you can help out, please return this card with your name and address, and we will gratefully send you more details. Or call the Membership Office, 213/744-3426.

Yes, I'd like more information on becoming a volunteer.

Name _____

Address _____

City & Zip _____

Telephone _____

Mail to
Becky Chapman · Membership Dept. · 900 Exposition Boulevard · Los Angeles, CA 90007

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Winter Workshops

Hand-Building Pottery

Ramon Landivar, Instructor

Eight meetings, Mondays and Wednesdays

January 14, 1985-February 11, 1985 (No meeting 1/21/85)

9:00 A.M.-11:00 A.M.

\$50 members, \$55 nonmembers

Ramon Landivar, resident conservator at the Bowers Museum in Santa Ana, will instruct this class in hand-building primitive pottery. You will learn to make your own clays, to coil and pinch simple forms, to decorate with painted designs, and to fire your own pieces. Demonstrations, lectures, and films will accompany this workshop. Limit twenty people. Materials about \$5 extra.

Advanced Pine-Needle Basketry

Judy Mulford, Instructor

Saturday, February 23, 1985

9:00 A.M.-4:00 P.M.

\$20 members, \$25 nonmembers

An opportunity for experienced basketweavers to add new stitches to their repertoire. Tenerife and woven beginnings, varied stitchery, and basket lids will be the subjects taught in this one-day workshop. Limit ten people.

Zoological Illustration

Mark Hallett, Instructor

Eight meetings, Saturdays, March 2, 1985-April 27, 1985

(No meeting 4/6/85)

9:00 A.M.-12 Noon

\$65 members, \$70 nonmembers

Students are invited to join an eight-week, 24-hour seminar that will explore the concepts and illustrative methods of biological drawing and painting with special emphasis on the art of illustrating animals. Under the instruction of Mark Hallett, a skilled illustrator whose article on *Iguanodon* appears in this issue of *Terra*, students will explore the subjects of animal psychology, anatomy, and movement to help them express drama in wildlife illustrations. The course will touch on design and layout, graphic reproduction, and careers in biological illustration. Limit twenty people.

For enrollment information, please call Joan Grasty at 213/744-3341.

GLAZA ZOO

Announcing a very special benefit for Museum Members

Now you can enjoy free admission to the fabulous Los Angeles Zoo, subscriptions to Zooview magazine and GLAZANEWS, and all the benefits of membership in the Greater Los Angeles Zoo Association at a *substantially reduced rate*.

REGULAR MEMBERSHIP \$20 (regularly \$25)
admits two people

FAMILY MEMBERSHIP \$25 (regularly \$35)
admits your entire household

You must have a current Natural History Museum Membership to qualify for these special discounts! Be sure to indicate your museum membership number on your application.

.....OFFER EXPIRES APRIL 30, 1985.....

Yes! I'd love to be a GLAZA Member!

- *\$ 20 Regular (admits two)
- *\$ 25 Family (all household members)
- \$100 Sustaining
- \$250 Curators' Guild

Name _____

Address _____

City _____ State _____ Zip _____

Telephone () _____

MUSEUM MEMBERSHIP # _____

My check for \$ _____ is enclosed.
(Made payable to GLAZA)

Please charge \$ _____ to my ☐ MasterCard ☐ VISA

Card No. _____

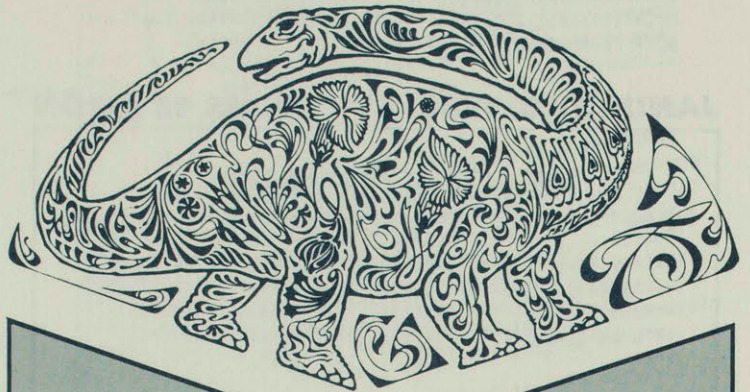
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MAGIC DINOSAURS

The Dinosaur Ball

Ever catch a Tyrannosaurus rex performing prestidigitation—sleight of hand? Or see a Stegosaurus's sorcery? "Magic Dinosaurs" is the theme of this year's **Dinosaur Ball**, and you are sure to fall under our prehistoric spell March 23, 1985. This gala event, the Natural History Museum's premier fundraiser, promises to be the enchanting highlight of the Southland's spring social season.

Some six hundred guests will join the dinosaurs at the ball, dining and dancing the night away doing the Pterodactyl Tango, the Reptilian Rumba, and the Cretaceous Conga. Tickets for this Brontosaurus of a ball are \$200 per person and include a formal dinner in the dramatic setting of the museum's mammal halls (among other halls) where exotic wildlife dioramas will surround guests. Afterward, guests can trip the light fantastic with Tyrannosaurus, Triceratops, and company.

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the second and more feisty individual was the much more common Mastiff bat, *Molossus molossus*.

At Mount Plenty Cave, only a few miles from the north coast resort of Ocho Rios, can be found a phenomenon reminiscent of a scene from a Jules Verne novel—a miniature subterranean fig tree forest. Mount Plenty Cave is home to a large population of several species of plant (phytophagous) and insect-feeding (insectivorous) bats. In the deepest reaches of the cave roosts Leach's Long-Tongued bat, *Monophyllus redmani*, a nectar- and insect-feeding bat that nocturnally fills the same ecological niche as Jamaica's diurnal hummingbirds. However, it is the bats that live nearer to the entrance of the cave that provide the seed for this forest. The Jamaican Fruit-Eating bat, *Artibeus jamaicensis*, feeds extensively on the fruits of the wild fig tree, carrying its prizes back to the cave at the end of its foraging flights. The seeds of the fruits, and many partially eaten figs themselves, fall to the floor and quickly take root in the rich guano substrate. The plants send up ghostly white shoots and leaves to a height of perhaps two feet before their energy reserves are exhausted, and then, unable to photosynthesize in the darkness of the cave, they die, to be replaced from the endless rain of seeds from above.

The guano of these plant-eating bats supports different insects and spiders than the excrement of their insect-eating cousins. Mount Plenty Cave is home to at least two insectivorous species, the Mustached bat, *Pternotus parnelli*, and the Ghost-Faced bat, *Mormoops blainvilli*. Their guano, which accumulates in levees several yards high, is black, moist, and composed of the finely chewed chitinous remains of insect exoskeletons. Chitin, which the bats can't digest, passes through the bats' alimentary canal unchanged and is processed by a bacterial flora and a excrement-eating arthropod fauna—most notably the cave cricket *Uvaroviella*, whose enormous antennae functionally replace eyes in the total darkness of the cave. The plant-eating bats' guano consists of an earthy matrix and large quantities of leaves, twigs, fig skins, and a tangle of dead fig seedlings. Roaches and crickets are scarcer but are replaced by a diverse assemblage of smaller arthropods, of which tiny white sow bugs are the most apparent component. The primary decomposers in this relatively dry guano community are fungi, which in turn feed many of the arthropods.

The most exceptional of all the Jamaican bat caves is undoubtedly St. Clair Cave, near the town of Ewarton. Essentially an oxbow of the above-ground Black River, St. Clair Cave now carries the normal flow from the dry surface stream bed. The main passage, of

The air, vibrating with the beat of a myriad of unseen wings, resembles some kind of Stygian sauna bath.

railroad tunnel dimensions, runs right through a hillside from the St. Clair entrance to the Lemon Ridge entrance. Eleven species of bats are known to live in the cave, including the Jamaican Flower bat, *Phyllonycteris aphylla*, unique to the island. It is the cave's smaller side passage, however—aptly named Inferno Passage—that provides the most memorable experience of the St. Clair system. A tall, narrow rift passage, Inferno Passage is home to tens of thousands of bats. The floor of the passage is largely occupied by thigh-deep pools of fetid water and liquid guano. The walls are a living carpet of scavenging invertebrates—cockroaches, cave crickets, millipedes, and innumerable smaller forms. The air, vibrating with the beat of a myriad of unseen wings and raised some five to six degrees by the heat of the bats' bodies, resembles some kind of Stygian sauna bath and is filled with a rain of bat urine and excrement. Sick or young bats that lose their grip and fall to the floor are rapidly consumed by carnivorous insects, while their more fortunate colleagues host clouds of parasitic flies that show an unwholesome attraction to the visiting cavers' lights. Rats and feral cats occupy the drier regions of the cave, also feeding on the dead bats and larger insects but relying solely on smell and touch to find their way in the absolute darkness. In a community such as that of Inferno Passage, the combination of insectivorous and phytophagous guano in huge quantities, an elevated temperature, and water in the form of a small stream results in a troglomorphic assemblage of extraordinary density. As many as one million arthropods per square yard have been estimated in a similar cave in Trinidad, with cockroaches alone numbering over one hundred to the square yard.

When evening falls, the spectacle of the bat caves can be enjoyed in more comfortable surroundings. As dusk approaches, the bats begin their exodus, streaming out of the caves on their way to feed. At Winsor Great Cave, the large circular chamber just inside the entrance acts as a gathering area for bats moving up from the deeper regions of the cave. As they reach the chamber, they join a huge cloud of bats circling the chamber in uniform clockwise fashion. Occasion-

ally a few bats will peel off and dive out of the entrance to test the light intensity, flying back if it is still too bright. As darkness falls and the skies fade to the bats' liking, the whole population begins to stream out of the entrance and spiral into the night.

Oxford Cave, generally around thirty feet wide and a half-mile long, constricts just inside the entrance to an opening that is a mere two feet wide and three feet high. Each evening a population of tens of thousands of bats of several species must funnel out through this tiny bottleneck to feed. The sight of a seemingly solid column of bats pouring from the entrance is breathtaking, and all the more so when one contemplates the navigational sophistication needed to accomplish such a feat in total darkness through the competing ultrasonic "sonars" of thousands of other bats.

The exploration of Jamaica's bat caves is not entirely without risk and should not be undertaken lightly. While some caves, such as Oxford Cave, are largely horizontal, others, such as Monarva Rat-Bat Cave, descend steeply and require a good deal of scrambling. Other bat roosts may be located deep in pit caves requiring rope or ladder descents of hundreds of feet or in active river caves subject to flash flooding.

More insidious perhaps is the dangerous lung disease histoplasmosis. The infective organism is a fungus that grows on bat and bird guano, and its spores are common in the air of caves with big bat populations. Almost everyone who visits tropical bat caves is exposed to the fungus and develops a positive skin test to the histoplasmin antigen. Only a few people develop clinical symptoms, but these are often very serious and resemble pneumonia. It had been thought that dry, dusty caves were primarily responsible for serious manifestations of the disease, but the epidemiology now seems more complex and is poorly understood.

Jamaica's bat caves are a unique and valuable resource. Besides their economic contribution to the farming community as renewable reserves of fertilizer, the insectivorous bats they support are invaluable aids to insect control, and several nectar-feeding bats play important roles in the pollination of tropical fruit plants. To the biologist, the caves are irreplaceable refuges for species of bats and invertebrates found nowhere else on Earth and are deserving of the highest degree of protection.

Don McFarlane is a Fellow of the Royal Geographical Society, coordinator of bat conservation activities for the National Speleological Society, and an inveterate Englishman. Currently a graduate student in the Section of Mammalogy, his research interests focus on the ecology and biogeography of tropical bats.

Tops

This year's holiday exhibit at the Natural History Museum features tops from the Robert E. Wade collection, many of which are on public display for the first time. This collection, containing almost nine hundred tops from all over the world, was donated to the museum in 1984 by his wife, Addie Wade.

Mr. Wade, Chief of the Natural History Museum's Exhibitions Division until 1978, began collecting tops in 1969 after a luncheon discussion on children's games. Said Mr. Wade in a 1972 *TERRA* article: "I brought up the subject of disappearing children's games and stated that spinning tops had all but vanished from the playgrounds. This statement was challenged and a wager was made. I'm glad to say that I lost the bet. However, it took my friend some eight or nine months to find a top that he had said could be found anywhere. One bright morning in the summer of 1970, there on my desk was a new string top that he had at last found. Much to my surprise, and I think also the staff, the memory of how to wind the string and spin the top had not been forgotten."

Realizing that top spinning was fast becoming a lost art, Mr. Wade and his wife began collecting tops. Among those appearing in the museum's exhibition are gyroscopes, diabolos, whirligigs, spring, yoke, finger, and whip tops. There are peg tops from Mexico, whistling tops from Japan and Indonesia, plunger tops from the United States, an *alouette* from France, and choral tops from Germany, which whistle tunes while spinning. One very unusual wooden peg top stands fourteen inches tall and weighs nine and one-half pounds.

The exhibit of Robert E. Wade's top collection will continue until March 10.

—John Cahoon

Diabolo, ca. 1920, with original box. This rubber and wood diabolo looks like two tops joined at the point. As shown on the box, a child would spin the diabolo along a string suspended between two sticks. The diabolo could be "walked" along the string and could even be tossed in the air and, with skill and luck, caught again.

Finger or spinner tops. The small circular metal discs with wooden shafts were advertising premiums for Buster Brown Shoes and Manufacturers National Bank. Those tops shaped like a flat hand were spun to determine who would pay for food or drink. These two particular spinner tops, advertising establishments in Hermosa Beach and Whittier, also doubled as bottle openers.

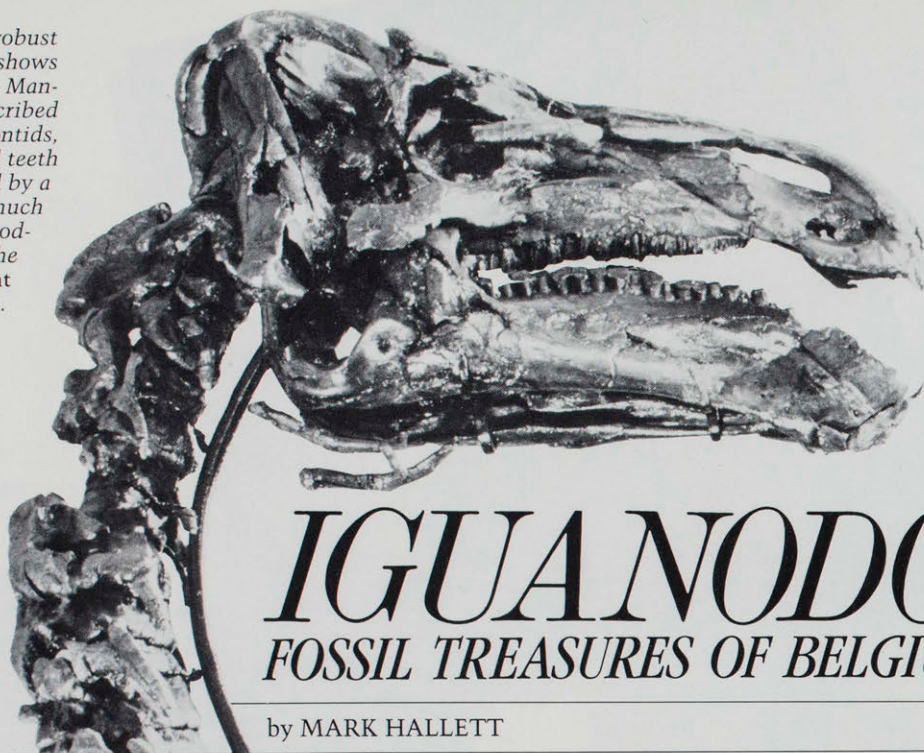
Modern plunger tops. Mechanical plunger tops were nineteenth-century modifications of the basic top design. Children thrust a spiral thread or screw downward into the top to make it spin. Repeating this motion several times could produce a humming sound.

This giant wooden peg top from Mexico is the largest top in the collection, weighing nine and one-half pounds and standing fourteen inches tall. The smaller top is also from Mexico. It has been colored with brown and red dye; polished, incised designs have been added at the shoulder and equator. Discs of ivory nut have been added to the hollowed-out equator and at the top.

Gyroscope. The principle of the gyroscope, a rapidly spinning wheel set in a framework that allows rotation around any axis, was incorporated into this dancing ballerina produced during the 1930s.

Photographs by Dick Meier

The skull of the robust *I. bernissartensis* shows its teeth. Gideon Mantell, who first described the iguanodontids, thought the fossil teeth his wife found by a roadside looked much like those of the modern iguana, hence the name iguana + dont (tooth).



IGUANODONS

FOSSIL TREASURES OF BELGIUM

by MARK HALLETT

Photographs by Veronica Tagland. Illustrations by Mark Hallett

They rear in graceful alarm, looking like giant statues from a past age. These bronze skeletons in their glass cage at the Brussels Natural History Museum speak silently of a time ancient beyond human comprehension. They are all that remain of great dinosaurs called *Iguanodon* that lived about 100 million years ago in the area we now call Belgium.

The *Iguanodon* skeletons in Brussels are among the most beautiful and scientifically valuable fossils ever found. They played an important role in the development of paleontology, and they may yet have much to tell us about the lives of dinosaurs. For these reasons, we were concerned a year and a half ago when we heard that the bones had been deteriorating. Some reports indicated that they were being attacked by industrial pollutants in the air and were gradually falling apart.

At one point there were even rumors that the famous fossils might be removed from display in an effort to halt deterioration. This prompted us to travel to Brussels as quickly as we could because we wanted to study the skeletons while they were still fully assembled and, if possible, to aid in efforts to save them. We also planned to stop off in London to discuss with Dr. David B. Norman of Oxford University, a specialist in the study of *Iguanodon*, some intriguing new ideas about their appearance and paleoecology.

Iguanodon was one of the first dinosaurs known to science: in 1822 the wife of a country doctor found some

Iguanodon teeth by a roadside in southern England. Mary Ann Mantell showed the teeth to her husband Gideon, who was an amateur paleontologist, and the resulting paper became the first scientific description of a dinosaur.

Dr. Mantell's report on *Iguanodon*'s teeth introduced the idea that giant prehistoric reptiles once lived on the earth. It was an idea that captured the popular imagination, and, as a result, *Iguanodon* quickly became famous. During the years that followed, many more teeth and bones were found in England, and paleontologists thought that these dinosaurs were unique to Britain.

But then, in 1878, the greatest *Iguanodon* discovery of all occurred in a coal mine in Belgium. A team of miners digging an exploratory shaft near the Belgian town of Bernissart discovered nearly twenty-nine perfect skeletons as well as many smaller vertebrates and plants, in a *cran* or marl-filled fissure. It took three years to excavate the huge concentration of bones, but when the material was studied, it told a fascinating story of ancient life and death.

In the early part of the Cretaceous period, about 100 million years ago, the area around Bernissart was a vast tropical plain. The fossil plants from the coal mine tell us that the weather was warm, humid, and rainy. There were rivers in the area, and much of the low-lying ground may have been marshy. In some places the plain was broken by ravines or gorges.

The *cran* in which the skeletons were found was thought by the excavators to

have been such a ravine in ancient times. The bones were smashed and scattered at the bottom of the fissure, while many of the skeletons above were still well preserved and articulated. Early investigators concluded that individually or in a herd the animals had either drowned or been stampeded to their deaths at the bottom of the ravine. Until this time few dinosaurs were well known; the remarkable find gave paleontology its first opportunity to study the skeletal morphology of a single species. What, then, do we now know about *Iguanodon*?

Iguanodon and its close relatives the hadrosaurs or duck-billed ornithomimids were specialized descendants of the earlier bipedal camptosaurids. (A mounted camptosaurid skeleton and that of the predator *Allosaurus* may be seen in the main foyer of the Natural History Museum of Los Angeles County.) Originally thought to have been an isolated family restricted to Europe, iguanodontid fossils have recently been uncovered in such places as Africa, Australia, Asia, and the Americas.

Two genera are known from nearly complete skeletons. *Ouranosaurus* from Niger had greatly elongated spines along its back, the skin covering of which was supplied with a network of blood vessels that may have helped the animal avoid a lethal heat build-up in the desert environment in which it lived. *Muttaborasaurus* from Queensland, Australia, had a curiously enlarged and scalloped nasal area, the function of which is still unknown. Of the two known North American iguanodontids, *Tenonto-*

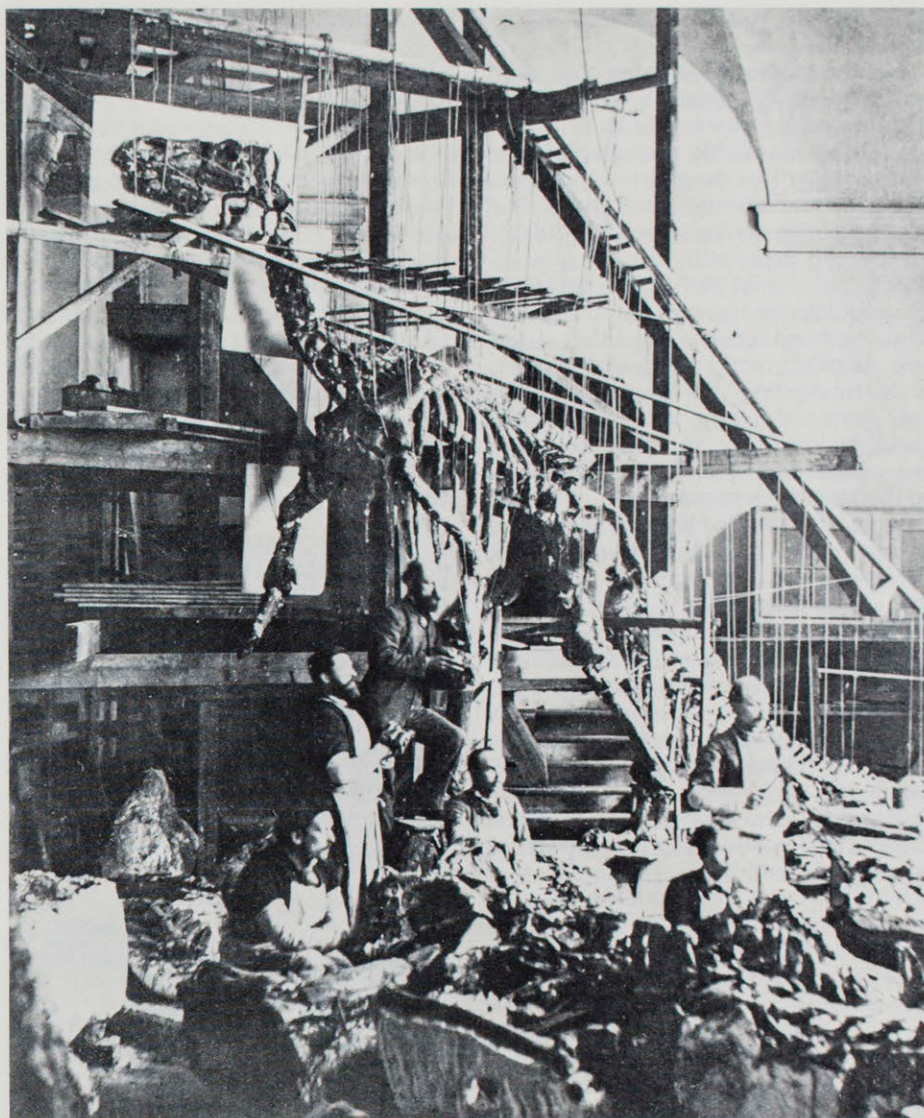
saurus was unusual for its deep and enormously long tail, which made up most of its twenty-one-foot length. Its bones have been found in association with the small carnivorous dinosaur *Deinonychus* in numbers that suggest the rapacious little predators may have hunted the iguanodontid in packs; perhaps against these *Tenontosaurus*'s long tail made an effective lashing weapon.

At least five closely related species lived in Europe, of which the best known are the two types found at Bernissart: *Iguanodon bernissartensis* and *Iguanodon atherfieldensis*. At one time paleontologists thought these to be male and female animals of the same species. However, a closer study of the fossils' skeletal proportions and morphology showed that they were different species with different habits. The smaller *I. atherfieldensis* was a two-and-one-half ton, twenty footer that usually walked on its hind legs; *I. bernissartensis* was a five-ton, twenty-nine-foot animal whose much longer, sturdier forelimbs and shoulder blades indicate that it usually supported its bulk on four legs. Biometric studies of the Belgian specimens conducted by Dr. Norman reveal an interesting fact: the forelimbs of the hatchlings and juveniles of the larger iguanodontid were small, much like forelimbs of the lighter, gracile *I. atherfieldensis*. As *I. bernissartensis* individuals grew older they developed the characteristically massive shoulders and arms of their kind, and thus they were better able to support their increasing weight.

Iguanodon was previously portrayed in restorations as a sort of Mesozoic hitchhiker with its jutting thumb and kangaroolike posture. However, modern animal biomechanics studies show that *Iguanodon*'s long, heavy body was balanced like a seesaw over its hind legs. A latticework of crisscrossing, ossified tendons strengthened its back against the excess stress.

Both forms had horny, continuously growing beaks with shearing surfaces that enabled them to crop fibrous vegetation. These dinosaurs ate plant material ranging from horsetails and cycads to tree bark, which they chewed in the rear of their mouths with batteries of grinding teeth that were replaced with others when they wore down. Dr. Norman feels that the jaws do not show any evidence for the giraffelike, prehensile tongue that Louis Dollo and earlier paleontologists gave *Iguanodon*, but that the dinosaurs did, as do giraffes and other modern mammalian herbivores, have muscular cheeks that contained the masticated food.

These dinosaurs also possessed unusually well-developed "eyebrow bones" or *palpebrals*. Perhaps these protected the iguanodontids' eyes during combat between animals of the same species and even could have sported some ornamen-



When the first *Iguanodon* skeleton was mounted in 1883, only the Brussels cathedral was big enough to house it.

Courtesy Institut Royal des Sciences Naturelles de Belgique. Copyprint: V. Tagland.

These four *Iguanodon* fossils were mounted rearing, an uncommon posture for the dinosaur, which generally walked and grazed on all fours.



tation or color to attract mates or intimidate rivals.

Recent studies also show that there was more to *Iguanodon*'s forefoot than just the well-known thumb spur. The forefoot was a highly specialized structure that featured, besides the spur, three enlarged and strengthened digits that supported the animal's weight while on all fours. A prehensile fifth "finger" opposed the rest of the foot, just as our thumbs oppose the rest of our fingers. When pressed against the other digits, this finger formed an efficient grasping organ for feeding. The finger performed in a way similar to that of the giant panda's "thumb" (or radial sesamoid wrist bone) to grip and bring vegetation to the dinosaur's mouth.

More light has also been thrown on the bizarre jointed first digit or spur. While the gracile iguanodontid's spike was merely a nubbin, that of the robust species was a huge, curved cone featuring a fifteen-inch claw that could be rotated across the inner side of the wrist. Although *Iguanodon* possibly used the spur in intraspecific rivalry, a more likely use is suggested by *I. bernissartensis*'s larger and more awkward body. While the gracile form fled from carnivores, the bulkier and slower iguanodontid stayed to defend itself. Rearing up to a height of sixteen feet, it could have used its massive forelimbs and lethal claws to gore and slash at the eyes and neck of any predatory dinosaur, such as *Megalosaurus*, that tried to deliver a killing bite to its throat. Predation on healthy adult iguanodontids was less likely, however, than attacks on the old or sick. The megalosaurids must have performed a valuable service to their prey by weeding out the unfit.

The iguanodontids were probably peaceful animals that must have spent their time foraging and resting, and the ancient mudflats of prehistoric Belgium show evidence of moments from the life—and death—of these giant herbivores. Fossilized trackways depict the dinosaurs' meandering course in search of choicer browse among the horsetails, and one bears the pointed three-toed prints of an interested megalosaur. One fossil slab shows where one dinosaur rested for a while, leaving an impression of its skin; another contains portions of an *Iguanodon* skeleton that shows young *Equisetites* (horsetails) growing up through the bones.

In addition to the iguanodontids themselves, the Bernissart find also yielded a wealth of smaller forms, including crocodiles, turtles, a salamander, fish, and a primitive insect related to the cicada. These creatures, which are usually associated with water, suggest that ancient Belgium was a seasonally wet and dry plain subject to periodic flooding. The abundance of *Equisetites* found in other such Wealden Age deposits

shows that these small horsetails probably covered the area in a green, waving sea. Toward the west the flat land was interrupted by deep gorges cut by sluggish rivers on their way to the Tethys Sea, a great inland ocean that stretched from western Europe through Asia. Along the gorges grew forests of *Araucaria* or monkey puzzle, *Sequoia*, cycads, and ferns of many kinds. The seasonal flooding that swept through these canyons explains the presence of this plant debris at Bernissart along with the freshwater Belgian fossils. Similar forests along the London Escarpment to the northwest sheltered a rich dinosaur fauna, which, besides *Iguanodon*, included the ankylosaur *Polacanthus*, a quadrupedal ornithischian bearing pro-

TECTIVE SPIKES and armored scutes along its back; the earliest known bone-headed dinosaur *Yaverlandia*; the small, lightweight ornithopod *Hysilophodon*; and such theropod predators as *Megalosaurus* and *Altispinax*.

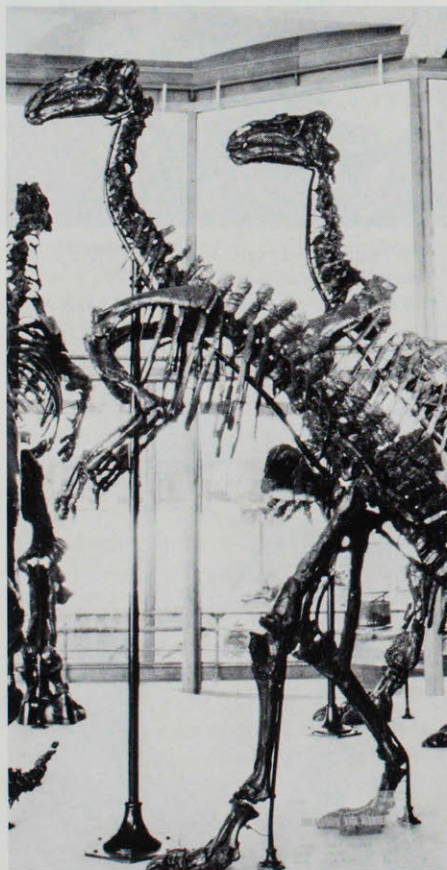
It was into such a forested gorge that earlier paleontologists thought the Bernissart iguanodontids had stampeded or had been foraging when drowned by a flood. Was this true? Did they all die catastrophically, or was there another explanation?

Geologically the Bernissart locality is made up of at least four successive fossil-bearing layers of sediment, the nature of which indicate that the Belgian area of ancient Europe was a flood plain that drained to the southwest into the Tethys Sea. The locality, which is a part of the extensive Wealden sediments that formed during the Early Cretaceous, overlies a lens of gypsum. Long after these deposits hardened and were buried, underground water action caused the gypsum to erode and the dinosaur-bearing sediments above to slump or collapse downward. The lowermost layers suffered the greatest fracturing, and the skeletons they contained received the most damage: the upper ones were less distorted, and their fossils were left more intact. The *Iguanodons* were not found side by side as they would be had they fallen or been drowned in a group. They were instead lying well above one another, the distance between the lowest and uppermost skeleton being about 110 feet. Instead of resulting from a single catastrophe, the remains were actually deposited in successive stages over hundreds to thousands of years.

The new study *taphonomy*, or what happens to an individual organism after death, provides an answer as to how the iguanodontids were deposited in their ancient graves. The head, tail, and limb positions of some individual skeletons are similar to those of large Recent mammals that have drowned and been transported by water. This, and the associations of aquatic vertebrates and forest debris, shows that the seasonal floods of Belgium swept the bodies onto the Wealden Delta, where they were covered and preserved by the sediments carried out by later flooding.

On leaving the interview with Dr. Norman, Veronica and I grew excited at the prospect of finally seeing and studying the *Iguanodons* in Brussels. I also gave some thought to our approaching discussions with the staff of the Belgian Royal Institute of Natural Science about the condition of the skeletons. We were aware that inaccurate and careless statements by foreign journalists about the famous fossils' conservation had made the museum's curators sensitive to questions about the iguanodontid's condition, and we wanted to combine our objective investigation

Rearing up to a height of sixteen feet, *Iguanodon bernissartensis* may have used its massive forelimbs and lethal claws to slash at any predator that tried to deliver a killing bite to its throat.



Side view of the two *Iguanodon* species. The more gracile *I. atherfieldensis* is in front. Note the bulkier head of the robust *I. bernissartensis* to the rear.

with the greatest possible tact.

The cordiality of Educational Director Dr. Alain Quintart's letter granting the photography and interviews was borne out by his and his staff's friendliness and cooperation in discussing the problems affecting the ancient bones. As we stepped from the museum's impressive modern laboratories toward the vertebrate fossil hall, the Belgians confirmed what Dr. Norman had told me in London about the skeletons. Like many fossils found in coal deposits, the bones were randomly impregnated with pyrite, or fool's gold, a mineral with a microcrystalline structure that breaks down when it comes into contact with oxygen. When factors such as high humidity and gases such as sulphur dioxide are added, the process rapidly accelerates, and a valuable specimen may weaken and crumble. In the case of the Belgian iguanodontids, the pyritized spots appear as yellow-orange areas against the bones' overall dark bronze color. Early preparators knew of this problem even before these particular skeletons were discovered, and when the Bernissart specimens were brought to Brussels in the late 1870s for preparation, a new technique was devised to preserve them. A specially constructed tank was built to contain a mixture of boiling alcohol, arsenic, and

carpenter's glue, a solution in which the fossils were soaked and dried. In some cases a plaster wall was built around the specimen to receive the mixture, after which the bone was flipped over so that the other side could be treated.

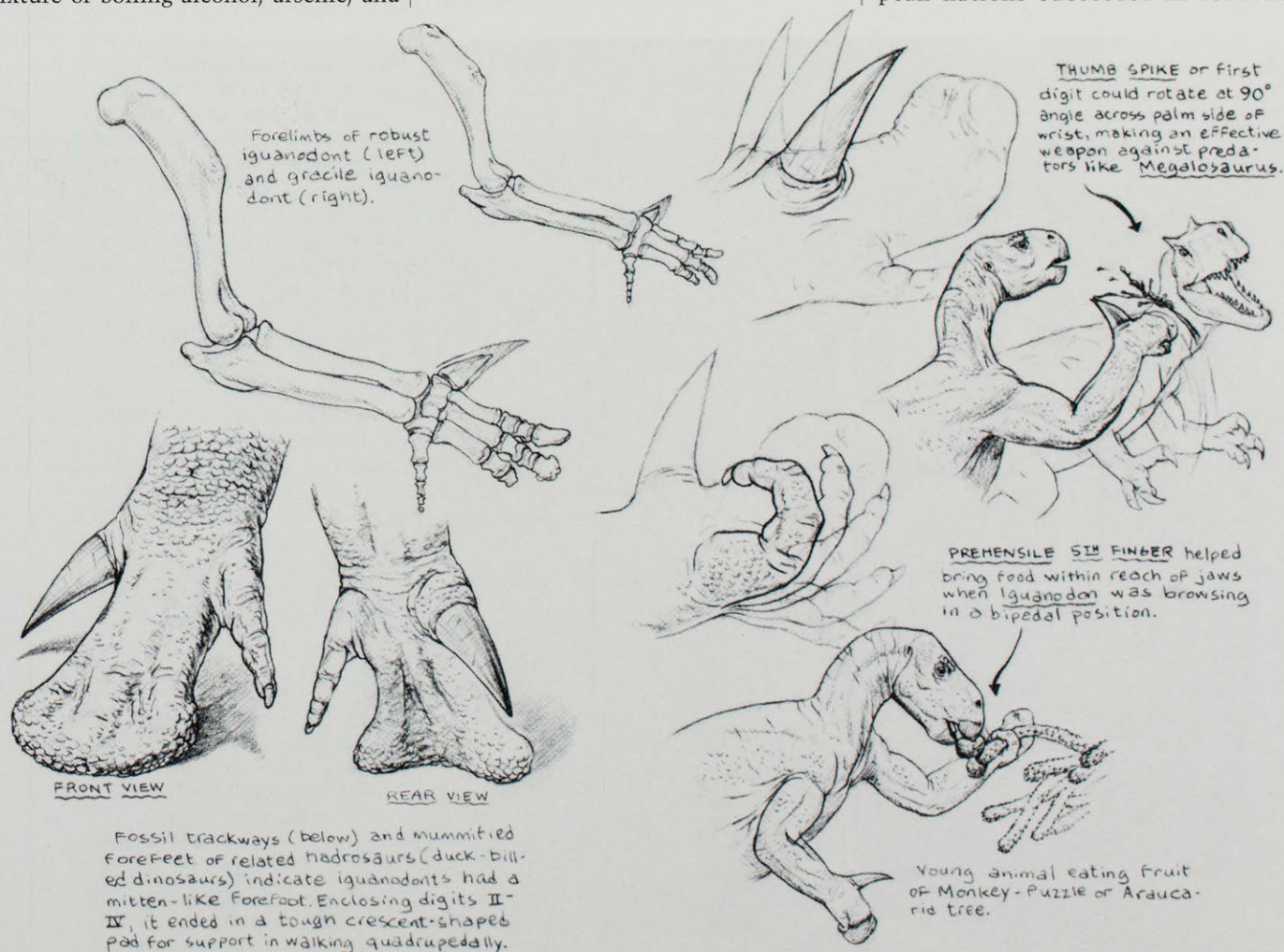
The technique appeared to be a success. Not only did the solution greatly strengthen the fragile bones, but it also sealed off the pyritized areas from the outer air. Now the spectacular finds could be prepared for public exhibit and studies. In 1883 the first of eleven skeletons chosen for display was mounted.

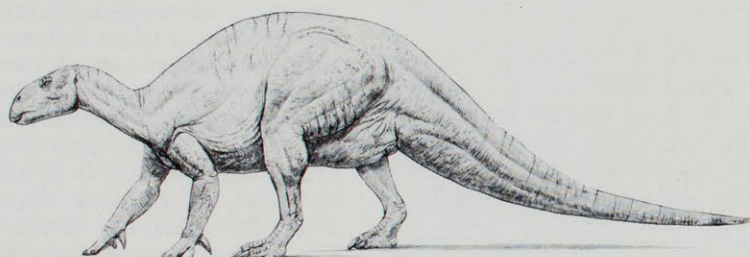
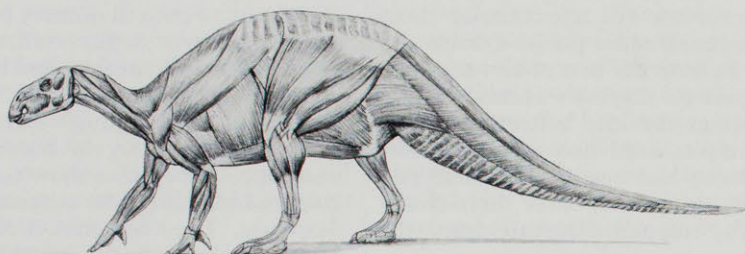
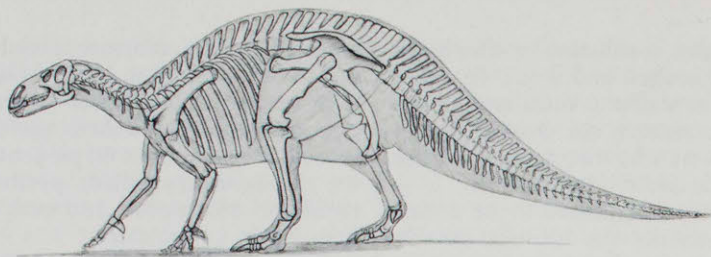
Almost as the last bolts were tightened, however, a sad discovery was made: pyrite decay had begun. The bone surfaces, drying quickly after their chemical bath, trapped moisture from the

hardening solution before it could evaporate and escape. High levels of humidity built up within the fossils, softening the glue that helped hold them together. At a critical level of about 60 percent humidity, the microcrystalline pyrite started rapidly to decompose, and with that the bone began to crumble.

The pyrite disease that gradually ate away at the skeletons grew more noticeable as the twentieth century began. The process became aggravated when the area's industry increased and began producing sulphur dioxides and other pollutants in large enough quantities to injure the bones. As the bones on their iron supports began to show signs of sagging and buckling, the curators became desperate. They felt that if further deterioration was to be prevented, they would somehow have to control the air conditions surrounding the dinosaurs. In the 1930s huge glass and metal enclosures were built around the mounted specimens and the fossils displayed as they were originally found. These enclosures and, later, modern hygrometers, which were installed to monitor excess humidity, helped slow the skeleton's decay. The curators' efforts were also aided when the postwar governments of Belgium and other western European nations succeeded in reducing

Fossilized trackways show the dinosaurs' meandering course in search of choicer browse, and one bears the pointed three-toed prints of an interested megalosaur.





local air pollution.

Because these measures were taken, the pyrite disease is considered by most visiting vertebrate paleontologists to have either slowed greatly or to now be contained. Frank Howie, a British expert on the problem of pyrite decay, feels that the bones' condition has now definitely stabilized.

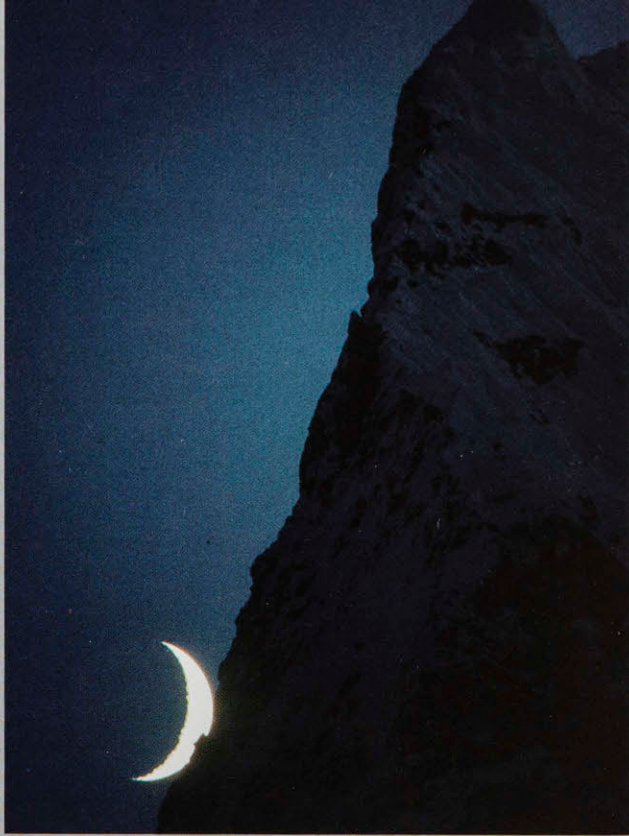
To see for ourselves, we inspected the mounted and in situ specimens during our photography session and compared the skeletons with photographs taken between the early 1900s through 1978. Although this method of comparison had its limits, it was apparent that little change in the shapes and outer surfaces of the bones had occurred since the thirties when the glass and metal cases were installed. I could see no evidence of recent decay among the free-standing *Iguanodon* mounts, and although one of the in situ skeletons showed a badly pyritized area on a rib, we found that this had resulted when water accidentally dripped through the case during a rainstorm.

Even though the pyrite disease plaguing Belgium's *Iguanodons* has been checked, both researchers and curators are frustrated by the fact that there is still no permanent way to counteract the destructive chemical reaction in the lab. If the Bernissart iguanodontids could be studied under ideal conditions without fear of exposing more of the bone to decay, even more knowledge about the evolution, anatomy, and skeletal function of these and other closely related ornithopods might come to light. The *Iguanodon* skeletons of Belgium have contributed much to our current understanding of dinosaurs; more may be learned if science can find a permanent way to preserve them.

A photographic illustrator, Veronica Tagland often combines her skills in documenting the ancient past with animal artist and author Mark Hallett to recreate the world of extinct life and to publicize the plight of endangered living animals and their habitats. Recently back from a trip to photograph and illustrate the mountain gorillas of Rwanda, they have also collaborated on recreating a life-sized section of the Amazon Rain Forest for the San Diego Zoo.

Top: A progressive restoration of the skeleton, musculature, and skin of *I. bernissartensis* shows us what the dinosaur must have looked like in life.

Bottom: These *Iguanodon* models in the British Museum of Natural History show the fleshy cheeks associated with herbivorous animals. Earlier restorations represented the dinosaur with a more lizardlike mouth extending all the way along the jaw line.



*Crescent moon and unnamed peak, Savoia Glacier,
Karakoram Himalaya; 1975*

Mountain Light

Photographs by GALEN ROWELL

Porters in the Braldu Gorge, Pakistan; 1975

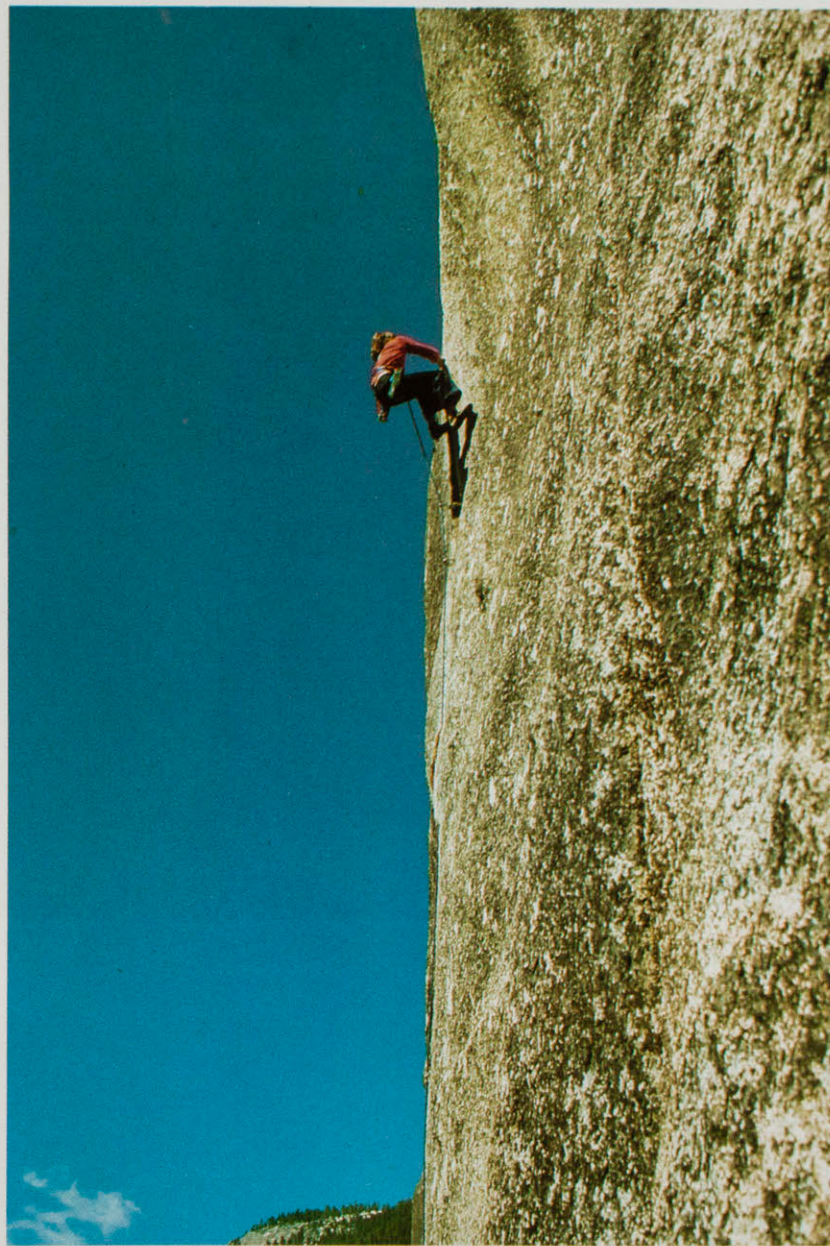




Mountain Light, an exhibit featuring Galen Rowell's luminescent images of some of the world's highest peaks, will be displayed in the Director's Gallery until April 15, 1985. Mr. Rowell's vistas have appeared in *National Geographic*, *Sports Illustrated*, *Audubon*, *American Photographer*, and in his own books, which include *Mountains of the Middle Kingdom* (Sierra Club, 1983) and *The Vertical World* (Wilderness Press, 1974). The peoples and wildlife of these mountainous areas are also featured in the Mountain Light exhibit.

Not only is Galen Rowell a photographer, but he is also a well-respected mountaineer. He has participated in major expeditions to Mount Everest and K2; on skis he accomplished the highest complete ascent and descent of a mountain (Mustagh Ata, 24,757 feet) and a 285-mile winter traverse of the Karakoram Himalaya. Nonetheless, after all this world travel, Mr. Rowell considers the mountains of California his favorites.

The museum's book shop will have cards and posters featuring Mr. Rowell's work as well as his most recent book, *Mountains of the Middle Kingdom*. Those interested can order prints of the Mountain Light photographs from the book shop.



Leading a climb called "Lunatic Fringe," Yosemite, California; 1973



"The fantastic dream castle of Shekar-Dzong," Tibet; 1981



Girl in a window, Srinagar, Vale of Kashmir; 1977

Lynx in alpine flowers, Teklanika River, Alaska Range; 1974



Open crevasses dwarf a bush plane, Kahiltna Glacier, Alaska; 1978





*Cirque of the
Unclimbables, Logan Mtns.,
Northwest Territories, Canada; 1972*

(Continued from page 2)

was named chief and served in that position until his retirement in 1968.

Mr. Smith and his staff organized the Chamber Music and Documentary Film series, the Natural Science workshop, the Docent program, the Lending Service, and the school tours.

Mr. Smith married Virginia Rice, assistant curator of the Junior Museum. She left the museum in 1946 to establish an audiovisual company, which the couple continued through his retirement.

—Gretchen Sibley

MOVEABLE MUSEUM RECEIVES AWARD

On October 29, 1984, the Los Angeles County Board of Supervisors recognized the Moveable Museum as the county's outstanding volunteer outreach program for 1984. Since the program's inception in 1982, educational presentations on Dinosaurs, North American Mammals, Indians, and California History have been given to over 10,000 students at local schools and libraries. The Moveable Museum is a project of the museum's Docent Roundtable, a volunteer group of more than 200 men and women work-

ing under the guidance of the Education Division.

DINOSAUR BALL DATE SET

"Magic Dinosaurs" is the theme of the Natural History Museum's Third Annual Dinosaur Ball, which will take place on March 23, 1985. Ball Chairman Mrs. Allan Herbert has organized an experienced and enthusiastic committee of party experts to handle every one of the hundreds of details that will add up to the grandest night of the museum's year. The "magic" theme promises many surprises, and some 600 guests are expected. You'll find out exactly what this gala night has to offer only by making your reservation right away!

As the Museum's premiere annual fund raising event, the Ball has been in the planning stages since last July. The Dinosaur Ball Committee is actively seeking underwriting for the entire event, meaning that the opportunity for raising in excess of \$100,000 for museum programs is a real one. Committee members are J. Shelton Ellis, Jr., Mrs. Robert Feinerman, Mrs. Robert Gelber, Ms. Lauren Leichtman, Mr. Marvin Lewis,

Mrs. Donald Petroni, Mrs. Thomas Reddin, Mrs. Charles Rinsch, Mrs. Charles Rosenbaum, Mrs. James Stewart, Mrs. Irving Stone, Mr. Harry Tytle, Mrs. James Young, and Mrs. Ray Zeman. Scene of the Ball will be the great Mammal Halls, though with an attendance that will most likely exceed last year's by a wide margin, other areas of the museum will be occupied as well.

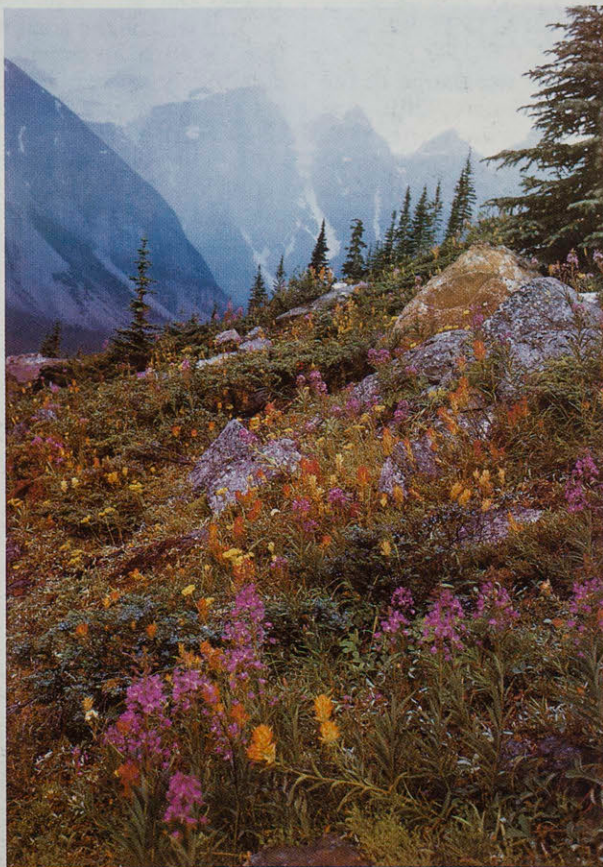
The Dinosaur Ball is a highlight of the spring social season in Southern California. And the fact that most, if not all, of the revenue from the \$200 per person tickets goes directly to benefit a cultural and educational treasure adds a special meaning to the occasion.

So mark your calendars, or better yet, reserve two seats, or a table, by calling the Dinosaur Ball Hotline, (213) 742-0822. Then bring out the black tie and the gown, put on that special piece of jewelry, and dance with the dinosaurs. Remember, March 23, 8:30 p.m., "Magic Dinosaurs," the Natural History Museum's Third Annual Dinosaur Ball!

The museum's Rotunda provided the romantic setting for cocktails and hors d'oeuvres at the 1984 Dinosaur Ball.



Sierra Club



W I L D E R N E S S S E R I E S

IN THE MUSEUM BOOKSTORE...

MOUNTAIN LIGHT is a spectacular exhibition of Galen Rowell's nature photographs on view at the museum through April 15, 1985. In conjunction with this exhibit, the Museum Bookstore is featuring a beautiful poster entitled "Mountain Wildflowers." For easy shopping, use the order blank below; for further information about Mr. Rowell's posters and fine photographic prints, call 213/744-3434.

NAME _____

ADDRESS _____

CITY/STATE _____ ZIP _____ PHONE _____

MOUNTAIN WILDFLOWERS POSTER BY GALEN ROWELL

Quantity _____ @ \$18.00 ea. Total _____

Museum Members' Discount - 10% _____

Subtotal _____

6½% Tax _____

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Natural History Museum of Los Angeles County
Exposition Park, Los Angeles, California 90007